Research Technical Completion Report

AN ASSESSMENT OF THE CAPABILITY OF EXISTING CANAL COMPANIES TO DELIVER ARTIFICIAL RECHARGE WATER TO THE SNAKE PLAIN AQUIFER IN SOUTHEAST IDAHO

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Submitted to

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SUMMARY

This work provides an assessment of the capability of existing canal companies to deliver artificial recharge to the Snake River Plain aquifer. Data are provided for each canal company examined in the study; as are discussions of the limitations and technical challenges inherent in artificial recharge of the aquifer using the existing delivery systems.

Recharge capabilities documented in this report are limited to the major canal systems overlying the Snake River Plain aquifer. Recharge opportunities or potential associated with new projects or developments, and the numerous smaller diversions were not addressed.

Artificial, or managed recharge refers to recharge of the Snake River Plain aquifer above that occurring as a result of current irrigation practices on the eastern Snake River Plain. For purposes of this study, we generally use the term "artificial" recharge for ease of reference when comparing this work to current and historical work on this subject.

This study addresses the capability of existing canal systems to deliver artificial recharge, assuming water is available. Water availability is an important consideration, since it is possible to have conditions where canal capability to deliver water to a recharge site exceeds the availability of water to do so.

Data for this study were obtained from existing canal company operating records held by Water District No. 1 and by interviews with canal company managers. Results of these interviews are documented in respective reports for each company, which are included as appendices to this study.

During the interviews, canal company managers refined our understanding of canal company operations and provided additional data regarding individual canal system recharge capability. This information was used to update our technical data for each system and to improve the accuracy of the tabular and graphical information for each company. The updates also included estimates of annual artificial recharge volume (in acre-feet) for each canal. These estimates were based on the respective company's technical data as developed and refined by our initial studies and the subsequent interview process.

In general, our study reached the following conclusions:

1. Existing systems are capable of recharging up to 1 million acre-feet annually, if water is available for recharge.
2. Nearly all irrigation districts and canal companies involved in this study support artificial recharge activities.
3. The greatest opportunities to deliver water to artificial recharge sites occur in the months of November, April and October; followed by March, May and September.
4. There is little support for managed recharge in the winter (December and January) because of the reluctance of managers to operate their systems in adverse weather and icing conditions.
5. In most cases, the opportunity for managed recharge during mid-summer is constrained because full canal capacity is needed to meet the system irrigation demand.
6. Numerous sites exist for managed recharge. The diversity of sites provides flexibility in points of diversion from the system, and in managing the timing and location of the

effects of recharge. This diversity can be used advantageously in system management and in development of mitigation schemes.

As a result of this study, we recommend that:

1. Existing artificial recharge projects should be continued and monitored to better understand the effectiveness of and the technical issues associated with artificial recharge.
2. Pilot recharge projects using existing canal facilities, where possible, should be developed and monitored to determine effectiveness and problems associated with implementation.
3. A theoretical investigation of recharge effectiveness should be initiated. The effort should include review of geologic evidence for hydrologic connection of recharge sites to the aquifer, and an assessment of timing and location of impacts from artificial recharge.
4. The results of this study should be utilized with an evaluation of water availability to produce estimates of recharge potential.
5. The Snake River Plain aquifer offers opportunities as a storage reservoir and a water conveyance system, if effectively managed. We should continue to pursue methods and mechanisms to manage recharge. We should also continue to expand efforts to improve management of all of our water resources.

Acknowledgments

This work required the support and cooperation of many participants. Central among these were the canal company and irrigation district managers and their staff. Many hours were spent in discussions with these individuals -- clarifying operating data and experience; sharing ideas and insights; and generally attempting to learn enough about their general operations to credibly support the goals of this report. These individuals also contributed by critically reviewing drafts of the appendices that describe our interpretation of these respective discussions. It is their interest in this task and their subsequent contributions that provide a unique degree of credibility in our overall findings.

Ms. Cynthia Defnet and Ms. Sherry Laney provided significant technical contributions to the study by gathering, organizing and presenting the volumes of data and myriad of calculations necessary to accurately reflect each company's or district's irrigation history. Their work is greatly appreciated.

Mr. Ron Carlson, the Watermaster for Water District No. 1, and Mr. Lyle Swank, the Assistant Watermaster for the district, helped to formulate boundaries for our analysis and to provide critical review and comment throughout the research and documentation process. Much of the general focus of this report is due in large part to their feedback and support throughout the study.

Mr. Bob Sutter, of the Idaho Department of Water Resources, also provided numerous suggestions for focusing our work, as well as critical review of and comment on our draft products. Through Mr. Sutter's advice and comment, the transition from this work to the Department's larger efforts is relatively straightforward.

Finally, we owe much to our families for their tolerance and support during the various stages of this work. They were always prepared to provide understanding and encouragement throughout the entire process. We are sincerely thankful for their unwavering forbearance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

Since the turn of the century, domestic and agricultural water usage on the eastern Snake River Plain in Idaho has continued to grow more complicated. Increased water usage, conversion to sprinkler irrigation systems, implementation of water conservation practices, and expansion of ground water based irrigation have precipitated the need for increased complexity in water management strategies in this area.

In the early 1950's, improved capabilities to pump ground water lead to further expansion and development of farm land in areas of the eastern Snake River Plain that were typically considered inarable due to remoteness from surface water irrigation sources. Water for these more remote areas was pumped from the underlying Snake River Plain aquifer. The aggregate effect of these changes in irrigation practices, combined with a five-year drought in southern Idaho from 1987 to 1992, are considered to be principal factors leading to significant decreases in the historical spring flows along the southern reaches of the Snake River between Milner Dam and King Hill (Kjelstrom, 1992). These spring flow reductions have been shown to closely correlate with decreases in water levels in the Snake River Plain aquifer (Kjelstrom, 1992). This is a significant hydrologic phenomenon because in July and August of dryer years nearly all streamflow in the Snake River upstream from Milner Dam is diverted for irrigation (Kjelstrom, 1992), which results in water users along the Snake River downstream of Milner Dam being highly dependent on natural spring flows for their livelihood. Although unaffected by flows past Milner Dam, an extensive aquaculture industry is also dependent upon the spring discharge.

Reduction in spring flow from the Snake River Plain aquifer has caused ongoing concern among water managers and water users alike. Consequently, patrons have called for state intervention to more effectively manage water as a vital state resource. To further exacerbate the perceived need for more effective management of the resource, numerous legal actions have been threatened or actually carried out, wherein the plaintiffs contend that ground water pumpers are depleting the water supply and directly affecting spring flows and depth to water in the aquifer.

In an effort to reverse or at least mitigate this trend, the state has implemented conjunctive management rules and legislated the formation of a recharge district in the southern portion of the plain. In addition, several studies of water resource utilization and interaction have been undertaken on behalf of the state to gain a better understanding of the complexities associated with management of this resource.

The phenomenon of surface and ground-water interaction affecting flows in the Snake River, particularly in its southern reaches in Idaho, has been recognized for many years. Mundorff and Norvitch, among several others, studied this phenomenon in the 1960's (Mundorff, 1962; Norvitch, 1969). Their work, along with more contemporary investigations (Barnett, 1996; McFaddan, 1996), suggests that by purposely allowing seepage and infiltration of water into the Snake River Plain aquifer, the aquifer will act as a storage medium and thereby mitigate or eliminate reduced spring flows above and below Milner Dam. In effect, the aquifer would be "artificially recharged" during plentiful water years as a storage buffer against water demand in future drought years.

Recent changes in Idaho water law have resulted in the need to manage both surface water and ground water to ensure earlier priority water rights are not injured by the water uses of later priority rights. This is commonly referred to as "conjunctive management". In principal, water usage will be managed such that surface-water and ground-water rights are jointly administered to assure the impacts on senior surface water users are appropriately mitigated. In practice, this is proving to be a daunting management assignment.

Managing recharge of the Snake River Plain aquifer has appeal to both surface water and ground water users. The intentional diversion of surface water to ground water storage has the potential to benefit both surface water and ground water users. Consequently, the Idaho Legislature set about to change water law to provide opportunities to artificially recharge the aquifer. In 1994 , the legislature recognized artificial recharge as a beneficial use of water for which a water right could be perfected. In March of 1995, the legislature appropriated nearly $1 million to purchase stored water for the purpose of recharging the Snake River Plain aquifer (Carlson, 1995).

Intentional recharge may also provide a mechanism to mitigate the water right impacts associated with ground water pumping. The law provides for mitigation of impacts to the rights of senior users by the junior users through use of formal mitigation plans. These plans may be designed to mitigate or eliminate damages to senior users through mutually agreeable conjunctive management of the water resource. Consequently, it is highly likely that a detailed technical understanding of the capability, availability, delivery and benefit of artificial recharge will become a much more important consideration in future water management strategies, legislation and litigation.

One should understand that not all "users" necessarily agree that artificial recharge is beneficial. Some interest groups oppose artificial recharge because they believe it will reduce river flows or lead to other undesirable effects in the environment. Such opposition will certainly need to be considered in the realm of both technical and legal merit, as well as for significance of political impact. However, these aspects of artificial recharge are not evaluated in this study.

Purpose and Scope

The purpose of this work is to provide an improved assessment of the capability of existing canal companies to deliver water to the Snake River Plain aquifer. Data regarding this capability for each canal company are provided in the appendices. The benefits of potential recharge to different users of the hydrologic system are also evaluated.

Recharge capabilities documented in this report are limited to those of major canal systems overlying the Snake River Plain aquifer. Recharge opportunities or potential associated with new projects or developments were not addressed.

"Intentional", "managed" or "artificial" recharge refers to the recharge of water to the Snake River Plain aquifer above that occurring as a result of current irrigation practices on the plain. For purposes of this study, we generally use the term "artificial" recharge for ease of reference when comparing this work to current and historical work on this subject.

The location and timing of recharge; capacities and capabilities; and a description of individual recharge sites for each delivery system are included in the appendices of this study. We assumed only minimum construction of new facilities would be required to accomplish the projected amount of recharge for each delivery system.

In conducting this study, we assumed that water will be available for recharge. Water availability is an important consideration, since it is possible to have conditions in the system where canal capability to deliver water to a recharge site exceeds the availability of water to do so. For example, water will either not be available for recharge during the height of the irrigation season or canals will have insufficient excess capacity to deliver the total potential recharge flow.

Description of Study Methods

Evaluations of canal capabilities for artificial recharge were conducted with the assistance of the managers of canal companies and irrigation districts. After discussions with IDWR personnel, regarding their expectations and needs from this work, we developed a general set of questions that were used to interview the various parties who participated in this study and thereby ensured consistent information was obtained during canal company interviews.

Concurrently, we held discussions with the Water District No. 1 Watermaster to determine specific canal companies and irrigation districts to consider for the evaluation. We narrowed our focus to those systems we considered would be most likely to have sufficient capacity and proper location to significantly improve capability to intentionally recharge the Snake River Plain aquifer.

Monthly average flow rates and the maximum flow for the fifteen-year period from 1980 until 1994 for each canal in the study group were obtained from the Water District No. 1 Annual Reports (Water District No. 1 Annual Reports, 1980 - 1994). Tables documenting these 15-year averages and flows for each delivery system, along with a graph of the key sections of these tables (monthly flow rates and the maximum flow rate for each canal), were generated for each major diversion (canal) under purview of each canal company or irrigation district. Water rights associated with each diversion were also displayed on the graph(s). This information (the tables and graphs) provided the preliminary technical information for each canal system. In addition, this information established the foundation for much of the canal system technical data found in the appendices.

Once our preliminary information for each company was developed (i.e., the graphs and corresponding tables of historic information), we interviewed the managers of

Table 1. Canal Company General Information.

Canal Company[1]	Appendix in This Study[1]	Approx. Service Area (acres)	Location of Diversion[2]	Date of Most Senior Water Right[3]	Date of Most Junior Water Right[3]	Appox. Storage Space Owned (AF)
Egin Bench Canal, Inc.[4]	A	30,000	See Note 5	1885	1939	66,000
New Sweden Canal Company[6]	B	31,000	See Note 7	1886	1939	93,000
New Lavaside Ditch Company	C	6,000	Near Firth, ID (T1S, R36E, Sec. 26[8])	1884	1984	12,000
Peoples Canal & Irrigation Company	D	20,000	Near Firth, ID (T1S, R36E, Sec. 26[8])	1885	1916	76,000
Aberdeen-Springfield Canal Company	E	45,000	Near Firth, ID (T1S, R36E, Sec. 34)	1895	1939	282,000
American Falls Reservoir District No. 2[9,11]	F	64,000	Milner Dam (T10S, R21E, Sec. 28)	1921	1921	404,000
North Side Canal Company	G	160,000	Milner Dam (T10S, R21E, Sec. 29)	1900	1920	852,000
Big Wood Canal Company	H	75,000	See Note 10	–	–	See Note 10
Lower Snake River Aquifer Recharge District[11]	I	See Note 12				

Notes:

1. Canal company order in this table is by location of diversion progressively from upstream to downstream along the Snake River. Appendix designations for each canal company are similarly assigned. For ease of reference and consistency, the two districts listed here will often be included in canal company lists without specific differentiation between the two (i.e., between canal companies and water or recharge districts).
2. Diversion locations are given by legal definition. That is, the locations are based upon the U.S. Federal Rectangular Survey, or the Land Office Grid System. For example, T1S, R36E, Sec. 26, refers to Township 1 south, Range 36 east, Section 26.
3. Most of the canal companies in this study hold several water rights. The most senior and junior dates are given here for general comparison. Refer to the specific appendix for each canal company for details.
4. Includes Last Chance, St. Anthony, Egin, St. Anthony Union and Independent Canals.
5. There are five separate diversions from the Snake River for this company. The Last Chance Canal diverts in T8N, R41E, Sec. 14; St. Anthony Canal diverts in T7N, R41E, Sec. 33, while the Egin, St. Anthony Union and Independent Canals all divert in or near the town of St. Anthony in T7N, R40E, Sec. 1.
6. Includes Great Western and Porter Canals.
7. There are two separate diversions from the Snake River for this company. The Great Western canal diverts in T4N, R37E, Sec. 35, while the Porter Canal diverts near Idaho Falls in T2N, R37E, Sec. 12.
8. New Lavaside and Peoples canal share the same conveyance system for approximately one mile downstream from a common point of diversion on the Snake River near Firth.
9. Often referred to as the Milner-Gooding Canal.
10. The Big Wood canal system is not expected to serve as a delivery channel for artificial recharge. (See Appendix H for details.)
11. The Lower Snake River Aquifer Recharge (LSRAR) District conveys water to its recharge site through the Milner-Gooding Canal, which is operated under purview of American Falls Reservoir District No. 2. The LSRAR District is included in this list for completeness. Refer to Appendix F, American Falls Reservoir District No. 2, and Appendix I for additional details.
12. The Lower Snake River Aquifer Recharge (LSRAR) District does not convey water as a direct service for water users. The sole purpose of the district is to divert water for artificial recharge of the Snake River Plain Aquifer when water is available to do so.

Big Wood Canal Company is the only irrigation system included in this report that does not divert water from the Snake River. Its source of water is the Big Wood River, in south central Idaho, and Magic Reservoir; which is located in the Big Wood River drainage. Appendix H provides additional detail.

Selection Criteria

Not all of the canal companies and irrigation districts that have attempted artificial recharge in the past were included in this study. Through consultation with Ron Carlson, Snake River Watermaster for Water District No. 1, the list of candidates for consideration was narrowed considerably. Selection criteria were developed that included:

1. The canal system has sufficient capacity to recharge additional water.
2. Recharge areas are located such that artificial recharge will enter the regional Snake River Plain aquifer.
3. Recharge can be accomplished without pumps, or without major construction or overhaul of existing facilities.

Several of the companies listed in Table 1 have been involved in recharge efforts for some time and have also participated in earlier studies similar to this work (Bookman-Edmonston, 1994). A brief comparison of related information from two of these earlier reports is provided in a later section of this report.

Study Area

The general study area of this report includes the eastern Snake River Plain overlying the Snake River Plain aquifer (Figure 1). The study area is generally bounded on the eastern and southern sides by the Snake River; and on the western and northern sides by the mountains that define the extent of the eastern Snake River Plain. Each

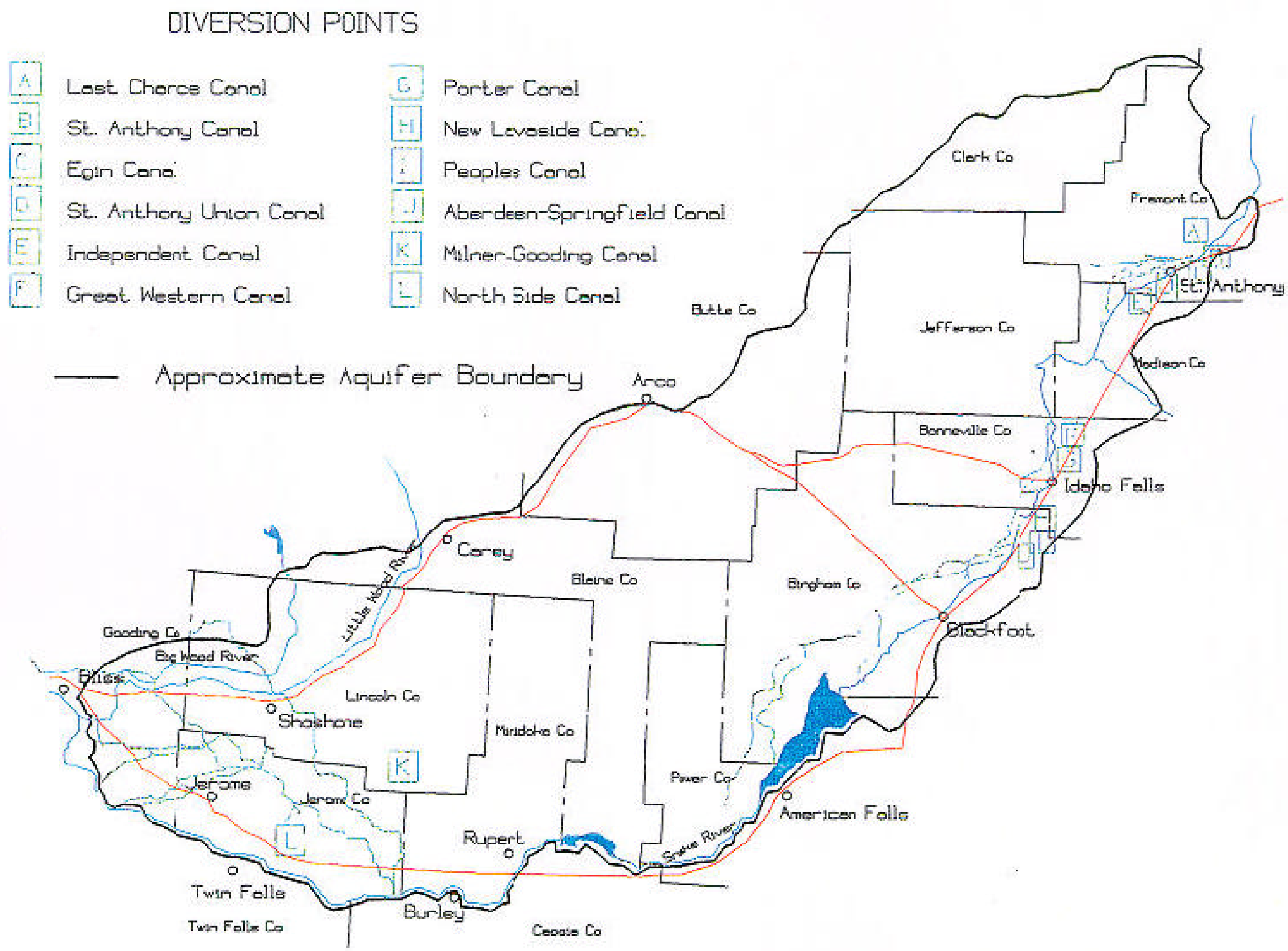

Figure 1. Canal Systems and Diversion Points on the Eastern Snake River Plain.

appendix contains a detailed description and map of the primary features of canal systems and recharge sites found in the respective canal system's service area.

Specific Example

The evaluation of each of the individual canal companies considered in this study includes a description of the system, historic diversions, water rights, recharge experience and potential for managing recharge. This information can be found in the respective appendix for each company (See Table 1 for cross-reference). Further explanation will be provided here by using Appendix C, the New Lavaside Ditch Company, as an example. Information in the other appendices was similarly derived.

The first step in the evaluation process for each company was to gather and organize historical data pertaining to company operations. Specifically, we were interested in the company's operating history during the 15-year period from 1980 to 1994. This period was selected because sufficient data were available in the annual reports produced by the Watermaster for Water District No. 1 (Water District No. 1 Annual Reports, 1980 - 1994) to provide a relatively long period for analysis. A long period was chosen to dampen any short-term data variations that might arise from drought, wet or abnormal operational years. Data in these reports are obtained from gaging stations and are judged to be of relatively high quality because of the methods, standards and frequency used to acquire and record the data.

Figure C-1 illustrates the use of these data. The average diversion bars in the figure are determined from data in the Water District No. 1 Watermaster Reports for New Lavaside. Monthly average flows for the 15-year period from 1980 through 1994 were used to calculate an average for the period, which is represented in the graph. The largest daily diversion in the 15-year period was taken as the maximum diversion capacity and is shown in Figure C-1. Water rights, determined from Water District No. 1 annual reports, are also represented in the graphs.

After the historical data for New Lavaside were gathered and organized in spreadsheet tables and graphs for the company, an interview with the company manager was conducted to validate and refine the New Lavaside data; and to discuss and document recharge experience as well as the potential for recharge for the company. Appendix C provides details with regard to the results of the interview.

Any additional recharge capability ("additional," is used to emphasize recharge exceeding that which occurs as a result of irrigation deliveries) identified during the interview is shown as a stacked bar in Figure C-1. In this example, New Lavaside is given credit for canal seepage in non-irrigation months and for recharge to a gravel pit throughout the canal system operating period. These values were derived from discussions with the New Lavaside manager as described in Appendix C. They are shown in Figure C-1 as "Recharge Canal Seepage" and "Recharge Gravel Pit", respectively.

The annual recharge capability for New Lavaside (and similarly for other canals) is shown in the upper-right corner of Figure C-1. This value was determined by converting average monthly recharge rates (cfs) to volumes (AF) and summing over the annual period. This value represents the capability to deliver and infiltrate water under the assumption that water is available. In most situations, availability is limited, and only a portion of the capability can be used to deliver artificial recharge.

Table 2 is a listing of the points of contact for each of the canal companies included in this study. These are the company or district personnel who participated in the interviews and generally assisted us throughout this study. Two individuals not listed in the table but are certainly worthy of mention in this regard are Mr. Ron Carlson, the Watermaster for Water District No. 1, and Mr. Lyle Swank, the Assistant Watermaster for Water District No. 1.

Table 2. Canal Company Points of Contact.

Canal Company [1]	Point(s) of Contact	Address	Phone Number
Egin Bench Canal, Inc.	Dale Swensen Bob Davis	Fremont-Madison Irrigation District P.O. Box 15 St. Anthony, ID 83445-0015	208/624-3381
New Sweden Irrigation District	Paul Berggren	New Sweden Irrigation District 2350 West 17th Street Idaho Falls, ID 83402-4815	208/523-0175
New Lavaside Ditch Company	Lyle Lindsay	New Lavaside Ditch Company 638 North 700 East Firth, ID 83236	208/346-6171
Peoples Canal & Irrigation Company	Cliff Merrill	Peoples Canal & Irrigation Company 1050 West Highway 39 Blackfoot, ID 83221-5307	208/684-3105
Aberdeen-Springfield Canal Company	Charles (Chuck) Yost	Aberdeen-Springfield Canal Company P.O. Box Y Aberdeen, ID 83210-0450	208/397-4192
American Falls Reservoir District No. 2	Richard Oneida	American Falls Reservoir District No. 2 P.O. Box C Shoshone, ID 83352-0802	208/886-2331
North Side Canal Company	Ted Diehl	North Side Canal Company 921 North Lincoln Jerome, ID 83338-1829	208/324-2319
Big Wood Canal Company	Richard Oneida	Big Wood Canal Company P.O. Box C Shoshone, ID 83352-0802	208/886-2331
Lower Snake River Aquifer Recharge District	Dan McFaddan	Lower Snake River Aquifer Recharge District 17966 U. S. Highway 30 Hagerman, ID 83332	208/837-6649

1. Canal company order in this table is by location of diversion progressively from upstream to downstream along the Snake River.

Interview results were summarized in a written report (the appendix narrative for each company) and spreadsheets and graphs were updated as necessary. In some cases, follow-up interviews were conducted to clarify information or to refine details. Ultimately, the narratives, tables and graphs for each company were finalized and then sent to each company for review and comment. Results of these canal company reviews were incorporated into each appendix prior to addition of the appendix to this report.

Assumptions, Limitations and Overview of Study

This section presents the assumptions and limitations of this work, as well as an overview of this study.

<u>**Assumptions and Limitations**</u>

1. This study does not include analysis of the availability water for recharge. The study is strictly focused on the capability of each company to provide water for recharge purposes. Further clarification of our scope in this regard is discussed in the "Purpose and Scope" section of this report.
2. Artificial recharge capabilities documented in this report include only those of major canal companies operating over the Snake River Plain aquifer. Recharge opportunities or potential associated with new projects or developments were not addressed.
3. Artificial recharge sites over the Snake River Plain aquifer were assumed to directly recharge the regional aquifer with no consideration for separating perched aquifers. No attempt was made to specifically analyze perching of recharge water or return flow of recharge water to a nearby surface flow system other than to discuss this possibility with the company representative(s) and in cases where the potential existed, adjust the recharge estimates accordingly. Geologic conditions near potential recharge sites should be addressed in further work focusing on the effectiveness and benefits of artificial recharge.
4. In some cases, seepage rates were difficult to differentiate from "normal" operational seepage. In these cases, further discussions were held with the company personnel to ensure normal seepage losses were not being counted as artificial recharge. Where necessary, values were adjusted prior to including them in our results. However, some doubts remain in some instances.

5. The Cottonwood recharge site in the Big Wood system and the LSRAR District site near the town of Carey have the potential to provide artificial recharge. However, due to unknowns and attendant uncertainties associated with their operation, contributions from their recharge potential were not included in this report. See Appendix H for further discussion and clarification of this topic.
6. Many canal companies are restricted from winter operations by weather conditions (e.g., frozen equipment, ice damage, road closure, snow blockage in canals, etc.) or lack of available personnel to support winter operations. Others either routinely operate in winter months or would be willing to operate to some degree during the winter. In these latter cases, credit was given for artificial recharge potential where appropriate. Refer to the appendices for details.
7. Some canal companies owning storage space in Palisades Reservoir are required by provisions in their contracts with the Bureau of Reclamation (BOR) to shut off diversion for 150 consecutive days each year. In cases where credit was given for artificial recharge potential during these shut-off periods, a tacit assumption was that the BOR would be willing to relax restrictions, should beneficial use of the restricted flow be available through artificial recharge.
8. Limited expansion of some recharge sites or delivery systems may require a cooperative agreement with the Bureau of Land Management (BLM), since some areas being considered are under the BLM's purview. In such cases, we assumed the BLM would be willing to cooperate in order to improve recharge potential.
9. Not all residents in areas impacted by artificial recharge necessarily agree that recharge is beneficial. There have been some instances of complaints being filed with local canal company managers because the perception was that recharge or extended periods of high canal levels resulted in damage to, or contamination of nearby wells. Others have suggested that recharge could accelerate the transport of surface pollutants into the aquifer. In these instances, we assumed the complaints, though in need of consideration, would not inhibit the company's ability to recharge.

10. In cases where a canal company felt they could increase their recharge capacity with relatively little additional expenditure of resources (typically less than $10K), credit was given for the expanded capability.

11. Several companies considered turning water into their systems early, if they could receive credit for canal seepage during this "early" period. In such cases, credit was given and the seepage values were included in the recharge potential for the company. However, once the "normal" operation period was entered, the additional recharge credit was removed from consideration.

12. Canal system maintenance practices vary throughout the water district. Careful consideration of these practices is reflected in the recharge potential values. When maintenance practices precluded system operation, even though diversion would have been possible, no credit was given for recharge.

13. Liability for operating some canal systems in non-irrigation months is an issue for canal companies whose systems more densely populated areas (e.g., Idaho Falls). In these instances, the potential for drowning or other water-related accidents is increased when the systems are full. Consequently, this liability is an operational constraint in the off-season. In such cases, no credit was given for recharge potential when the company representative indicated that to do so would be impractical.

14. Burrowing animals are a problem in some systems. The problems associated with their activity seems to be directly proportional to the amount of water in the system and the length of time the water is in the system. In such cases, impact on recharge potential was adjusted accordingly.

15. Diversion of Snake River water into the Big Wood River via the Milner-Gooding Canal in American Falls Reservoir District No. 2 represents a limited potential for recharge. This potential was not included in the recharge totals for this report because of the current uncertainties associated with this capability.

16. Artificial recharge near the Snake River in some areas may have relatively immediate impacts on nearby springs, but will be of limited value in terms of extended storage and retention of the recharge water in the aquifer. The

effectiveness and benefit associated with timing of recharge storage and retention were not addressed in this report. (See Item 3 in this list, above.)

Overview of the Study

An overview of this study is provided in this section. The tables and figures discussed were derived from the information for each canal company contained in the appendices to this report.

Figure 2 shows the maximum diversion potential for each of the canal companies considered in this study. The diversion capacity roughly represents the size of the canal system, and to a certain degree the capacity to deliver artificial recharge water. Maximum diversion capacity was determined as the maximum daily diversion in the selected 15-year period of study. Note that the Big Wood Canal does not appear in this figure. The Big Wood canal system is not expected to serve as a delivery channel for artificial recharge (see appendix H for details); therefore, it will not be included in summary data where flow or recharge potential is being summarized. The LSRAR District itself has no capacity to deliver water and is therefore also excluded from the summaries.

Recharge capability of most of the canal systems varies throughout the year. Because of freezing conditions in winter months, regular irrigation demand, canal maintenance, and other similar recharge constraints, there may be substantial periods of the year when there is no opportunity to transport sufficient water for recharge. The variations in capability are shown by the stacked bar graph of Figure 3. The graph shows that the months with greatest delivery potential are April, October, and November. This is due to the lack of irrigation demand during this period when freezing conditions do not yet pose major problems with canal operations.

March, May and September also represent months of reasonably good opportunity for delivery of artificial recharge water. These months represent the "fringe" months for

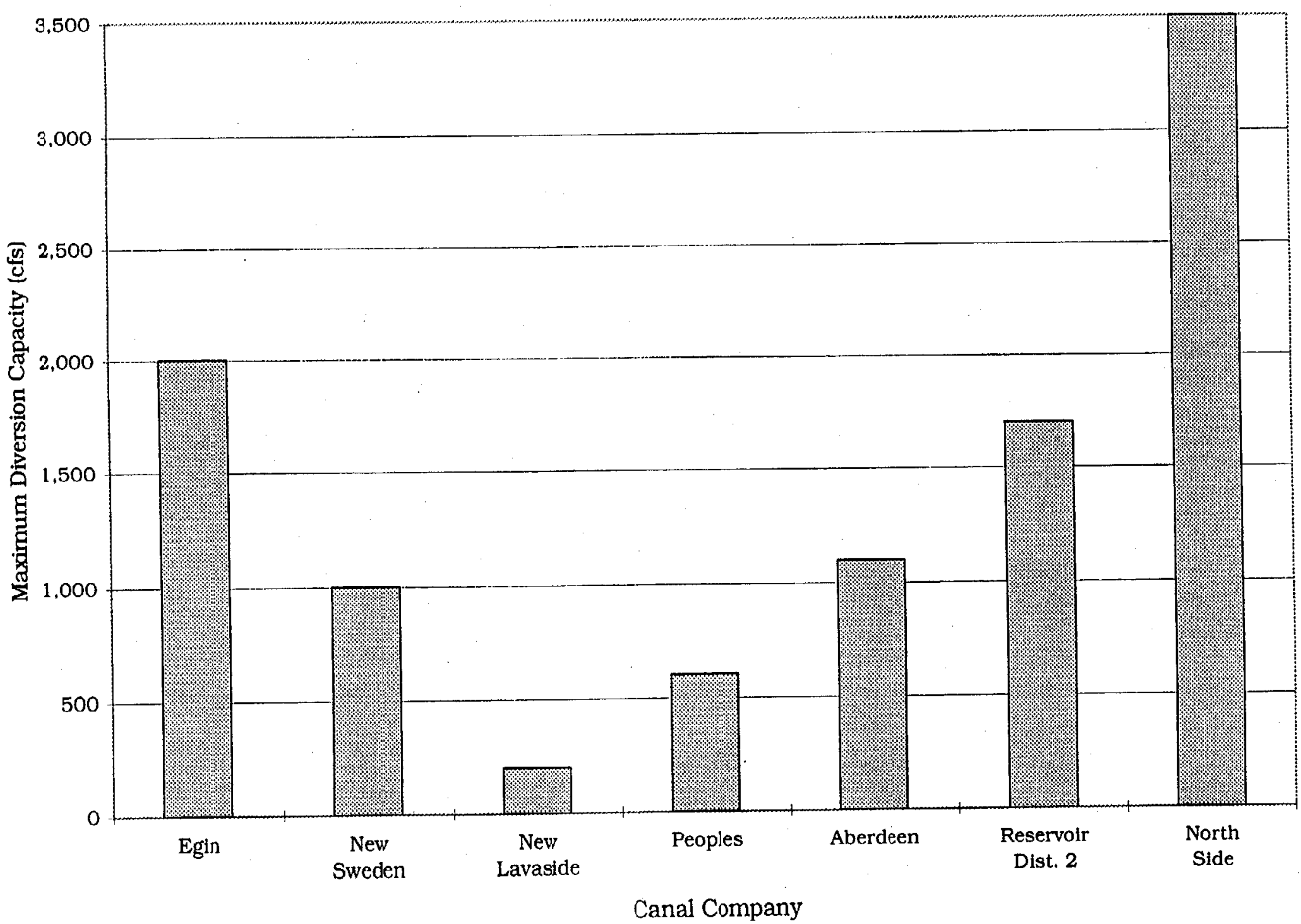

Figure 2. Maximum Diversion Capacity at Head of System.

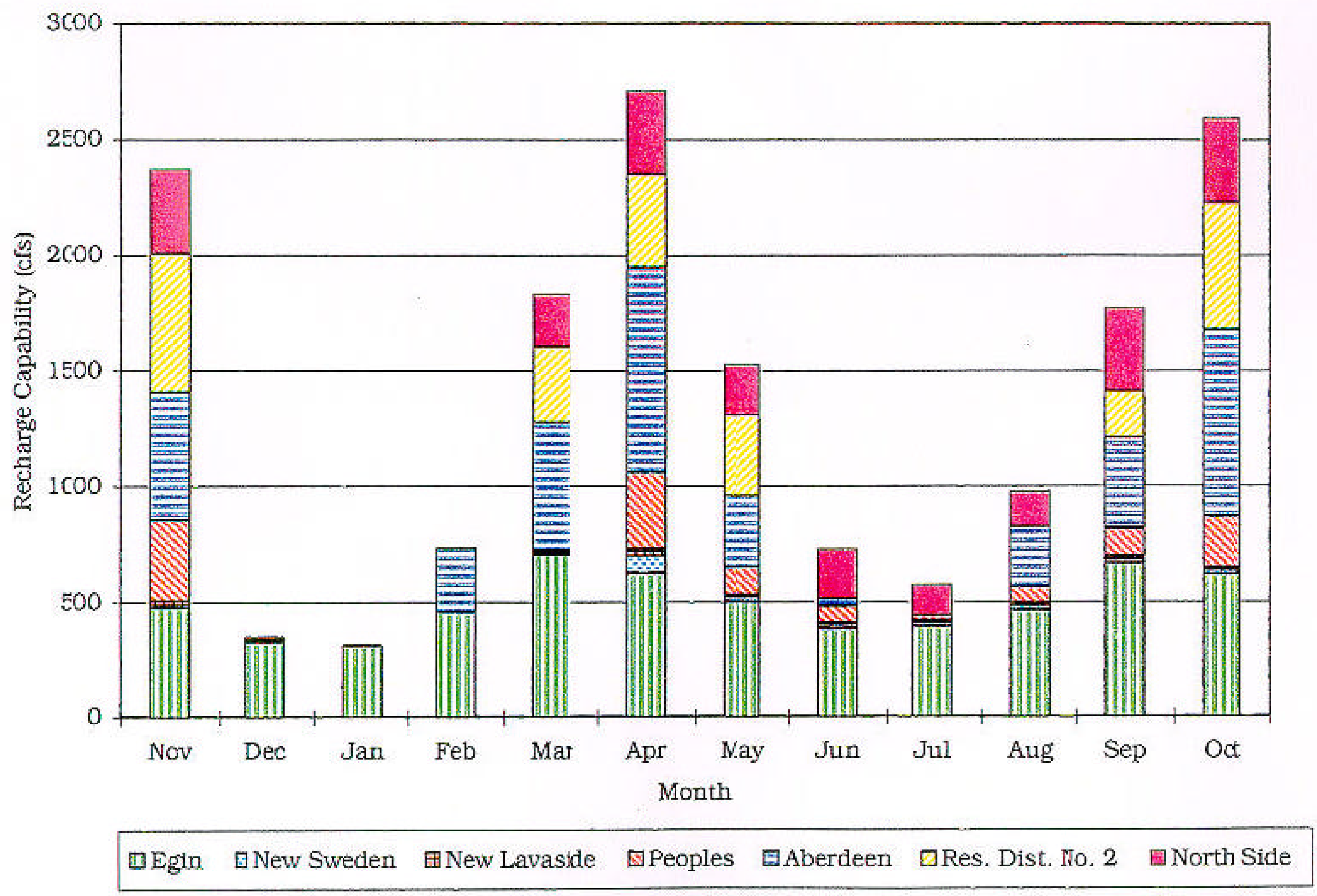

Figure 3. Total Monthly Recharge Capability by Individual Canal Company.

operation following winter, and prior to and immediately following high irrigation demands for the canal systems during the height of the summer growing season.

The rapid drop in potential in December reflects preparation of the systems for winter. Few of the canal companies were willing to risk operation in December because of the likelihood of early and prolonged freezing conditions icing their systems and damaging their equipment.

Figure 3 also shows the capabilities of individual canals as different types of bar shading. It is apparent that winter delivery of artificial recharge water is associated predominantly with Egin canals, which are constructed in a manner to make winter deliveries possible.

It must be noted that the delivery capability represented in Figure 3 includes numerous diversion points along the main stem of the Snake River and the Henry's Fork. These diversions are shown in Figure 1.

The annual capability to deliver artificial recharge water for each canal company or irrigation district is shown in Figure 4. The systems are shown in order from upstream to downstream (left to right). The relatively large recharge potentials of Egin and Aberdeen-Springfield canal systems are immediately evident. It is also apparent that the smaller systems; New Sweden, New Lavaside and Peoples; represent a small proportion of the overall potential to deliver artificial recharge water.

The sum of the capability for all canal companies is 920,000 AF. Derivation of the total artificial recharge capability for the entire irrigation system considered in this study is delineated in Table 3.

Table 3 provides a summary of values shown in Figures 2 and 4, as well as a convenient cross-reference to appendices for each of the canal companies should the

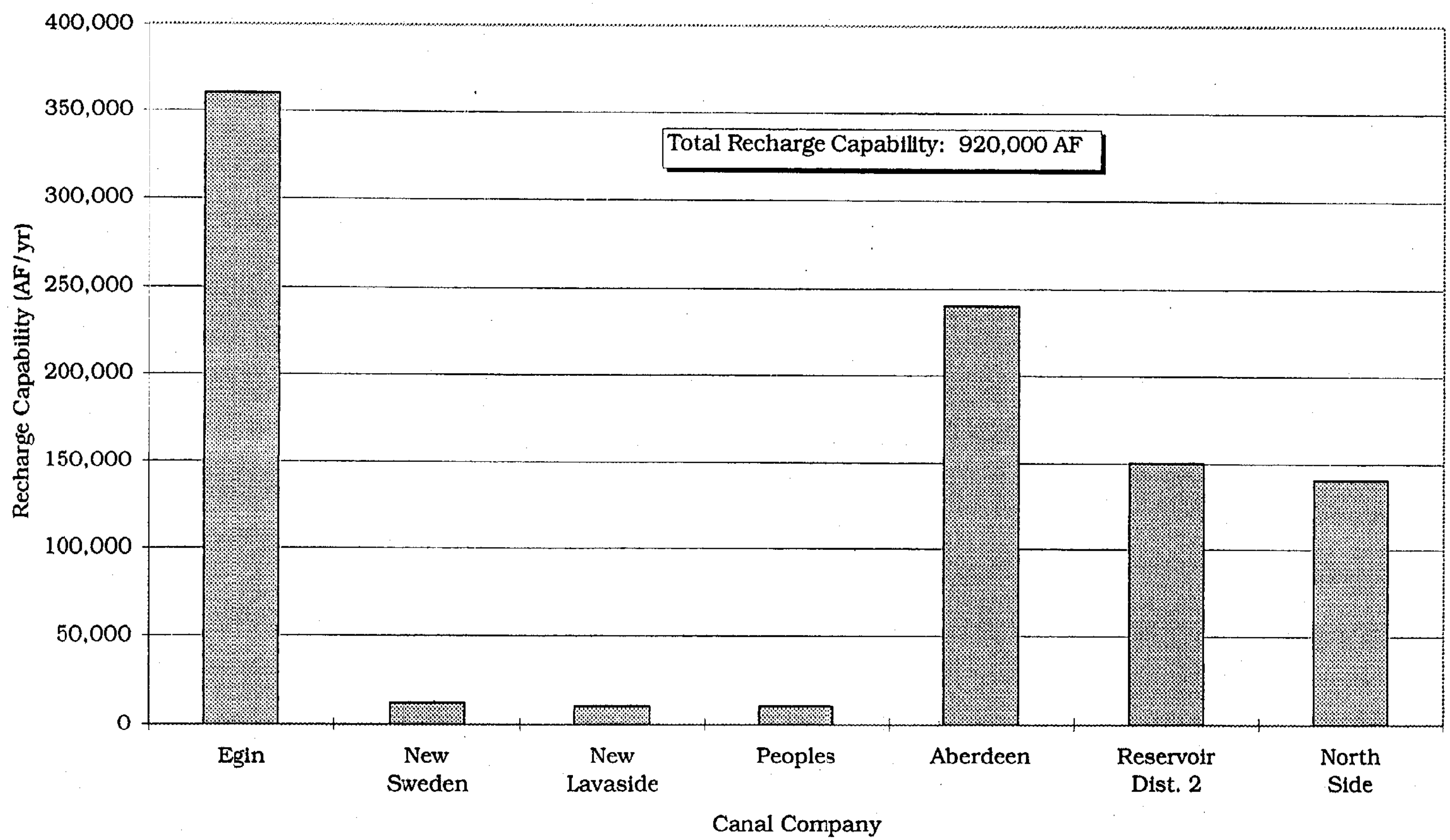

Figure 4. Artificial Recharge Capability.

Table 3. Canal Company Recharge Capability.

Canal Company[1]	Appendix in This Study[1]	Maximum Diversion Potential (cfs)	Annual Recharge Capability (AF/year)
Egin Bench Canal, Inc.[2]	A	2,000	360,000
New Sweden Irrigation District[3]	B	1,000	12,000
New Lavaside Ditch Company	C	200	10,000
Peoples Canal & Irrigation Company	D	600	10,000
Aberdeen-Springfield Canal Company	E	1,100	240,000
American Falls Reservoir District No. 2[4]	F	1,700	150,000
North Side Canal Company	G	3,500	140,000
Big Wood Canal Company[5]	H	--	--
Lower Snake River Aquifer Recharge District[6]	I	--	--
		Total:	**922,000**

Notes:

1. Canal company order in this table is by location of diversion progressively from upstream to downstream along the Snake River. Appendix designations for each canal company are similarly assigned.
2. Includes Last Chance, St. Anthony, Egin, St. Anthony Union and Independent Canals.
3. Includes Great Western and Porter Canals.
4. Often referred to as the Milner-Gooding Canal.
5. The Big Wood canal system is not expected to serve as a delivery channel for recharge. (See Appendix H for details.)
6. The Lower Snake River Aquifer Recharge (LSRAR) District conveys water to its recharge site through the Milner-Gooding Canal, which is operated under purview of American Falls Reservoir District No. 2. The LSRAR District is included in this list for completeness. Refer to Appendix F, American Falls Reservoir District No. 2, and Appendix I for additional details.

reader desire to investigate additional supporting information. The notes in Table 3 clarify several of the details associated with items in the table.

Figure 5 provides a generalized overview of all of the artificial recharge sites analyzed and discussed in this study. A rough estimate of the maximum recharge capacity (i.e., flow rate in cfs) at each of the sites is indicated by symbol shape and color for each site. This figure should be useful for quick determination of relative geographic location as well as capability of each of the sites. The appendices are available for added detail for each site, when such detail is necessary.

While there have been no detailed evaluations of the potential for artificial recharge in this area, the Idaho Water Resources Board, the United States Geological Survey (USGS) and, most recently, Bookman and Edmonston (1994) and Carlson (1995) provide information related to the potential for artificial recharge of the Snake River Plain aquifer. Bookman and Edmonston provided rough estimates of artificial recharge potential for the Snake River Plain aquifer. Carlson described the recharge efforts from the spring of 1995 for each of the participating canal companies and irrigation districts in Water District No. 1 and evaluated some impediments to using existing systems to increase recharge to the Snake Plain aquifer.

Table 4 provides a comparison of our results to the Bookman-Edmonston report and to the 1995 report by Carlson on the volumes recharged in Water District No. 1 that year. It is interesting to note the differences between Bookman-Edmonston recharge estimates and those actually documented in the Carlson report. These differences may provide perspective on the difficulty in predicting the volumes and successes associated with intentional recharge of the aquifer.

The estimates of recharge capability in this study reflect the best available. Most of the estimates are based on the judgment of those familiar with the canal systems; few artificial recharge values are based on actual measurement.

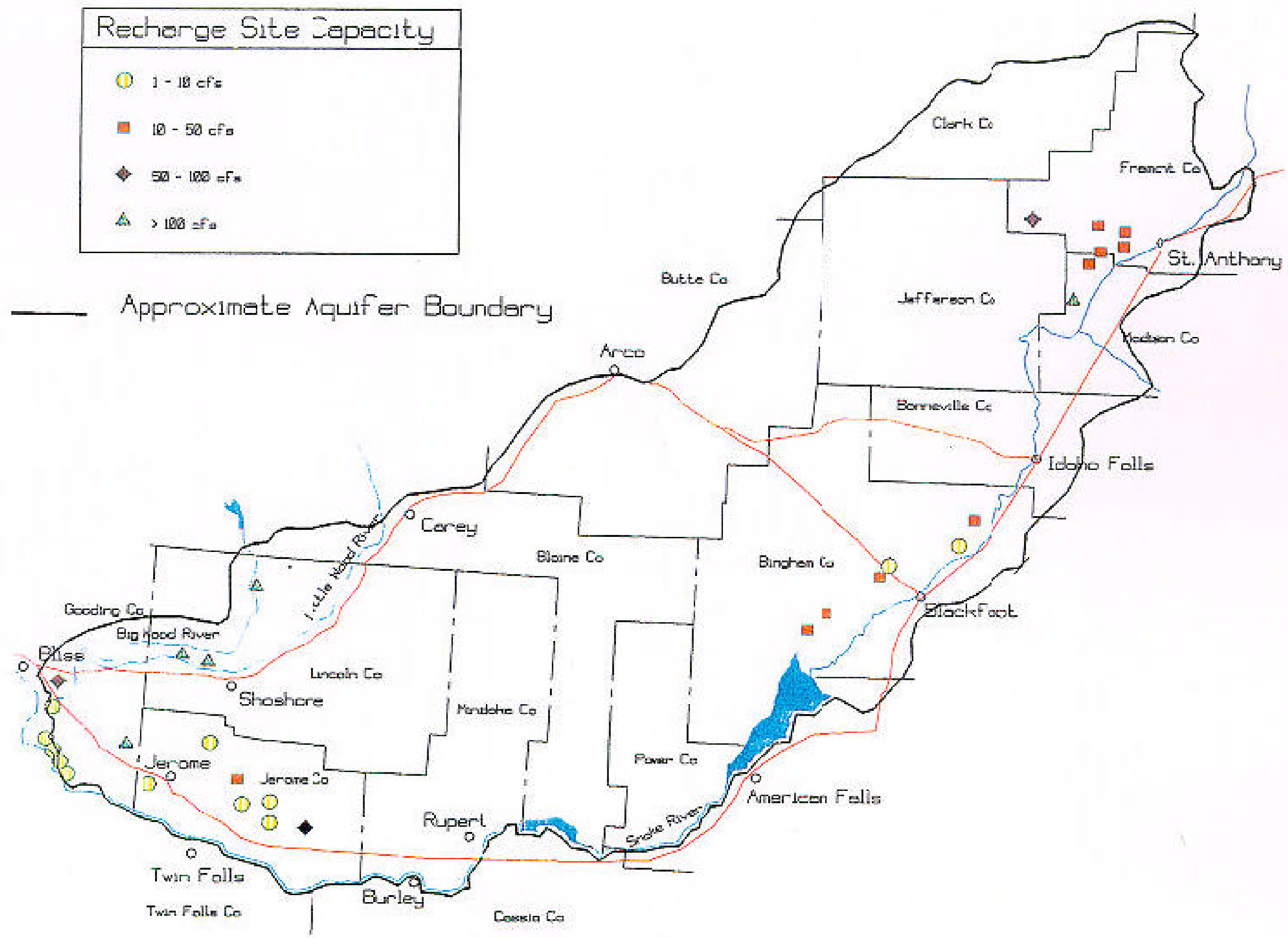

Figure 5. Capacity of Artificial Recharge Sites on the Eastern Snake River Plain.

Table 4. Comparison of the Results of This Study with Other Relevant Work.

		This Study (1996)		Bookman-Edmonston (1994)			Carlson (1995)	Differences Between Bookman-Edmonston and This Study					
								(Absolute Difference)			(Percent Difference)		
Canal Company[1]	Appendix in This Study[1]	Maximum Diversion Potential (cfs)	Annual Recharge Potential (AF/year)	Total Physical Capacity (cfs)	Estimated Non-Irrig. Season Recharge Volume (AF)	Total Estimated Annual Recharge Volume (AF)	Total 1995 Artificial Recharge (AF)	Total Physical Capacity (cfs)	Estimated Non-Irrig. Season Recharge Volume (AF)	Total Estimated Annual Recharge Volume (AF)	Total Physical Capacity (cfs)	Estimated Non-Irrig. Season Recharge Volume (AF)	Total Estimated Annual Recharge Volume (AF)
Egin Bench Canal, Inc.[2]	A	2,000	360,000	1,000	267,300	599,900	4,600	(1,000)	(92,700)	239,900	-50%	-26%	67%
New Sweden Irrigation District[3]	B	1,000	12,000		N/A[4]		5,377						
New Lavaside Ditch Company	C	200	10,000		N/A		N/A						
Peoples Canal & Irrigation Company	D	600	10,000		N/A		N/A						
Aberdeen-Springfield Canal Company	E	1,100	240,000	1,250	167,100	167,100	7,952	150	(72,900)	(72,900)	14%	-30%	-30%
American Falls Reservoir District No. 2[5]	F	1,700	150,000	1,600	401,000	454,200	48,248	(100)	251,000	304,200	-6%	167%	203%
North Side Canal Company	G	3,500	140,000	3,300	668,300	854,600	15,000	(200)	528,300	714,600	-6%	377%	510%
Big Wood Canal Company[6]	H	--	--		N/A		N/A						
Lower Snake River Aquifer Recharge District[7]	I												
Totals:		8,300 (See Note 8)	890,000	7,150	1,503,700	2,075,800		(1,150)	613,700	1,185,800	-14%	69%	133%

Notes:

1. Canal company order in this table is by location of diversion progressively from upstream to downstream along the Snake River. Appendix designations for each canal company are similarly assigned.
2. Includes Last Chance, St. Anthony, Egin, St. Anthony Union and Independent Canals.
3. Includes Great Western and Porter Canals.
4. N/A indicates that this canal company was not included in the work summarized in this column.
5. Often referred to as the Milner-Gooding Canal.
6. The Big Wood canal system is not expected to serve as a delivery channel for artificial recharge. (See Appendix H for details.)
7. The Lower Snake River Aquifer Recharge (LSRAR) District is included in this list for completeness. Refer to Appendix F and Appendix I for additional details.
8. For consistency of comparison, New Sweden, New Lavaside and Peoples canal companies are not included in these totals (i.e. the totals for the columns under This Study - 1996).

Other Technical Challenges

During the course of this study, several interesting technical questions arose that presented challenging opportunities for additional consideration. This section describes these challenges.

As mentioned earlier, the hydraulic connection between alluvial surface material and the basaltic aquifer beneath the recharge site was assumed to be sufficient to effectively allow for continuous recharge at the rates given. No attempt was made to specifically analyze perching of recharge water or return flow of recharge water to a nearby surface flow system. Validity of this assumption will certainly vary with the depositional environment and the underlying flow regimes, as well as with the operational characteristics of each canal system. Further technical investigation may be warranted where large uncertainties or conflicting measurement data justify refinement of the understanding.

The timing and location of the effects of recharge were not included in this study. When recharge occurs in proximity to a surface water body, the overall benefit may be questionable. Response of the aquifer to proximate recharge may be manifested immediately by increases in spring flow or possibly decreases in seepage from rivers and streams in the area. In some cases, immediate spring response may be desirable. In other cases, it may be that the storage characteristics of the aquifer are intended to mitigate or alleviate the impacts of multiple years of drought or other long-term situations. Given the relatively large number of recharge sites located in proximity to the Snake River (i.e., within ten miles) the short- or long-term nature of the impacts may become an important area of study in the near future.

Conclusions and Recommendations

After evaluating artificial recharge capabilities of various irrigation districts and canal companies, our study has reached the following general conclusions.

1. Existing systems are capable of recharging up to 1 million acre-feet annually, if water is available for recharge.
2. Nearly all irrigation districts and canal companies involved in this study support artificial recharge activities.
3. The greatest opportunities to deliver water to managed recharge sites occur in the months of November, April and October; followed by March, May and September.
4. There is little support for managed recharge in the winter (December and January) because of the reluctance of managers to operate their systems in adverse weather and icing conditions.
5. In most cases, the opportunity for managed recharge during mid-summer is constrained because full canal capacity is needed to meet the system irrigation demand. Effective canal management requires this priority for the agricultural customer.
6. Numerous sites exist for managed recharge. The diversity of sites provides flexibility in points of diversion from the system, and in managing the timing and location of the effects of recharge. This diversity can be used advantageously in system management and in development of mitigation schemes.

Recommendations include:

1. Existing artificial recharge projects should be monitored to better understand the effectiveness of and the technical issues associated with artificial recharge.
2. Pilot recharge projects using existing canal facilities, where possible, should be developed and monitored to determine effectiveness and problems associated with implementation.

3. A theoretical investigation of recharge effectiveness should be initiated. The effort should include review of geologic evidence for hydrologic connection of recharge sites to the aquifer, and an assessment of timing and location of impacts from artificial recharge.
4. The results of this study should be utilized to perform a follow-on evaluation of water availability. Jointly, this information should produce superior estimates of recharge potential.
5. The Snake River Plain aquifer offers opportunities as a storage reservoir and a water conveyance system, if effectively managed. We should continue to pursue methods and mechanisms to manage recharge. We should also continue to expand efforts to improve management of all of our water resources.

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APPENDIX A

Egin Bench Canal, Inc.

This report is a result of discussions between Fremont-Madison Irrigation District Manager, Dale Swensen; Egin Bench Canal corporation Watermaster, Bob Davis; and Gary Johnson, Walt Sullivan and Jason Casper of the University of Idaho. The discussions were held on April 12, 1996, in the office of the Fremont-Madison Irrigation District in St. Anthony, Idaho.

I. System Operation

In 1994, five separate canal systems in the area were consolidated to form Egin Bench Canal, Incorporated. The canal corporation has storage space in Island Park and Henrys Lake reservoirs and natural flow rights on the Henrys Fork of the Snake River. The Egin Bench canals are part of the Fremont-Madison Irrigation District. To ensure consistency in approach, each of these five canal systems will be included as subparts of this report, so that overall implementation of any recharge strategy will be accomplished through the Egin Bench Canal corporation, rather than attempted for each separate canal system.

Canal systems included in the Egin Bench Canal corporation are:

- Last Chance Canal
- St. Anthony Canal
- St. Anthony Union Canal
- Egin Canal
- Independent Canal

I.A Water Rights

The corporation holds water rights for each canal system as follows:

Canal System	cfs	Priority
Last Chance	225 (Until July 1) (120 after July 1)	1897
Total:	**225**	
St. Anthony & Union (i.e., both systems)	600 (When unrestricted and from July 17 - 31) (500, July 2 - 16) (500, after August 1)	1888 1892
	100	1892
	24	1939
Total:	**724**	
Egin	200	1885
	200 (When unrestricted and from July 17 - 31) (100, July 2 - 16) (100, after August 1)	1890
	23	1939
Total:	**423**	
Independent	400 (When unrestricted and from July 16- 31) (360, July 1 - 15) (360, after July 31)	1895
	35	1939
Total:	**435**	
Total for corporation:	**1,807**	

Time-constrained rights exist for each system because of the early practice of not using water for flood irrigation during the harvest of the first crop of alfalfa at the beginning of the summer. Downstream irrigators used the excess, causing it to become part of their decreed right. Under current cropping patterns (grain/potato rotation), the early summer pause in water demand no longer exists.

Total water rights are displayed in Figures A-1 through A-5 for each major canal in the corporation. Note that St. Anthony and St. Anthony Union graphs do not have a total water right displayed on the graph, since both canals share a total right of 724 cfs.

The Egin Bench Canal corporation owns storage in Island Park Reservoir and in Henrys Lake. Total storage owned is 65,737 acre-feet. Because the corporation has no contract for storage in Palisades Reservoir, it is under no winter water savings restrictions imposed by the Bureau of Reclamation; in contrast to many other irrigation districts and canal companies within the basin.

I.B Average Irrigation Diversions

Average monthly diversion rates for each of the five canal systems in this corporation are depicted in Figures A-1 through A-5. These values were obtained from Water District No. 1 annual reports. The diversion rates represent monthly average diversions for each canal for the fifteen-year period from 1980 to 1994, inclusive.

I.C Physical Description of the System

Egin Bench Canal, Inc. consists of five separate canal systems diverting water from the Henrys Fork of the Snake River. The corporation irrigates approximately 30,000 acres of agricultural land primarily south and west of the city of St. Anthony, Idaho. These five systems; Last Chance, St. Anthony, Egin, St. Anthony Union and Independent; are designed to be inter-

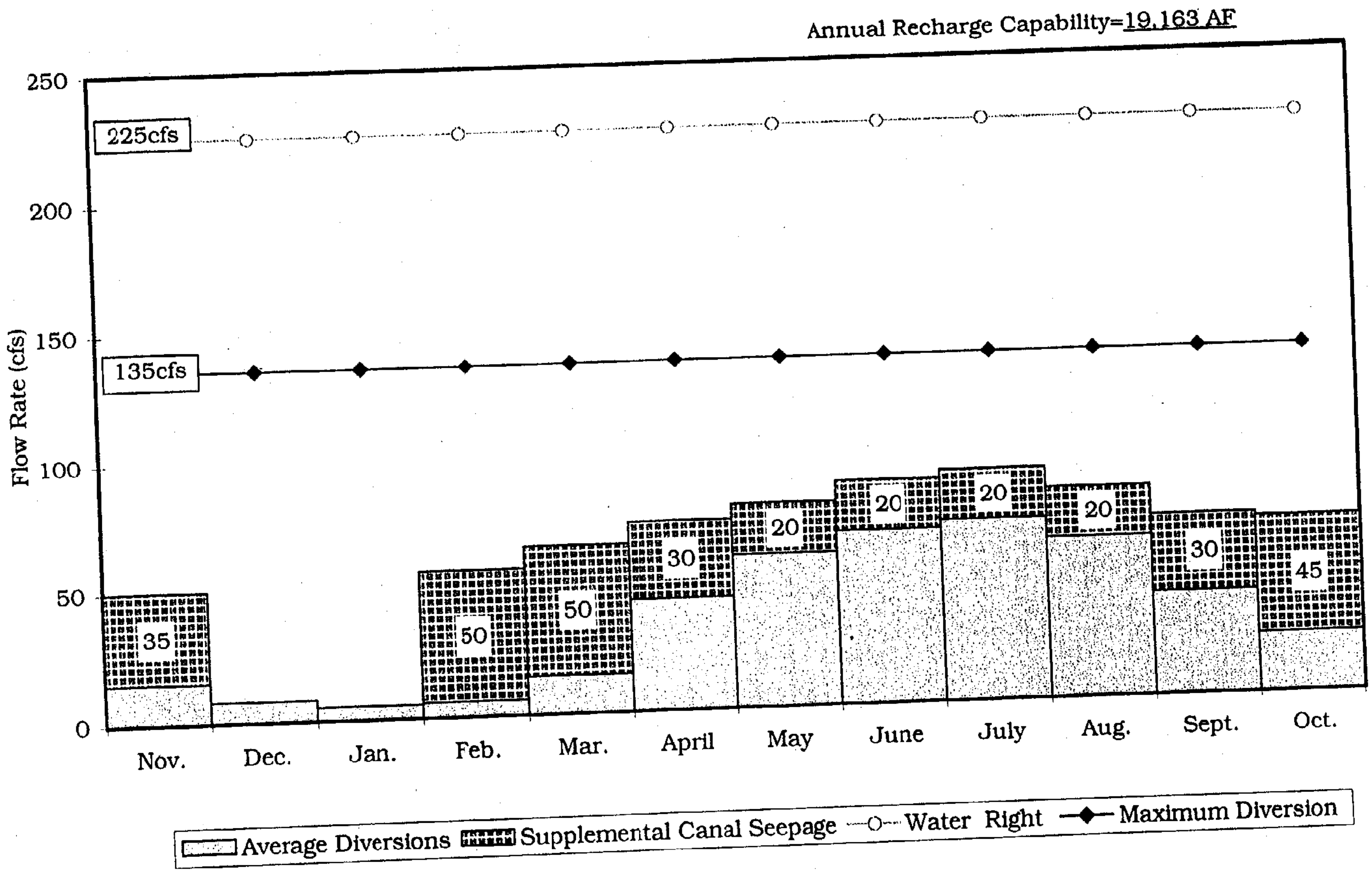

Figure A-1. Estimated Recharge Capability of Last Chance Canal.

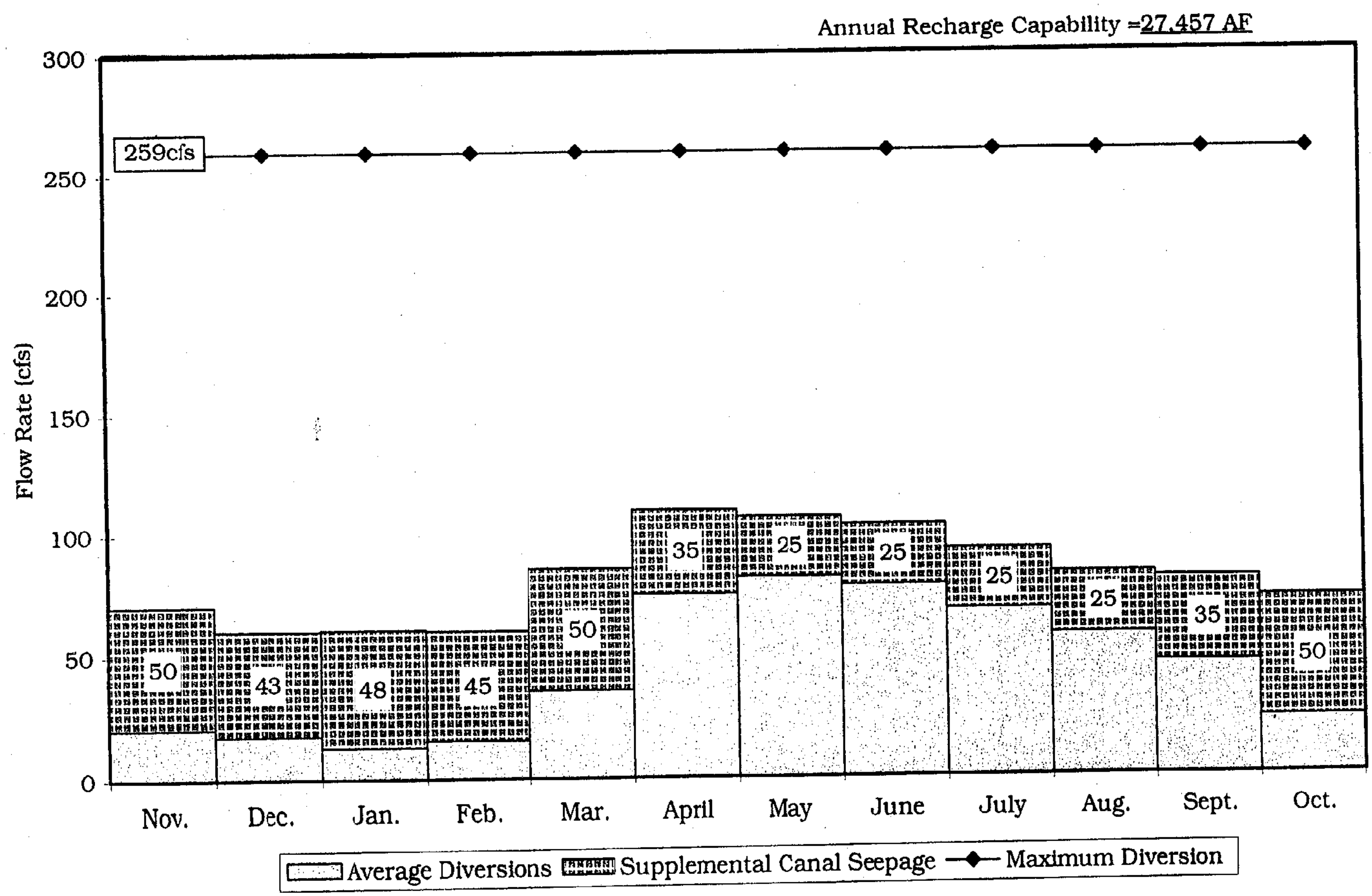

Figure A-4. Estimated Recharge Capablity of St. Anthony Union Canal.

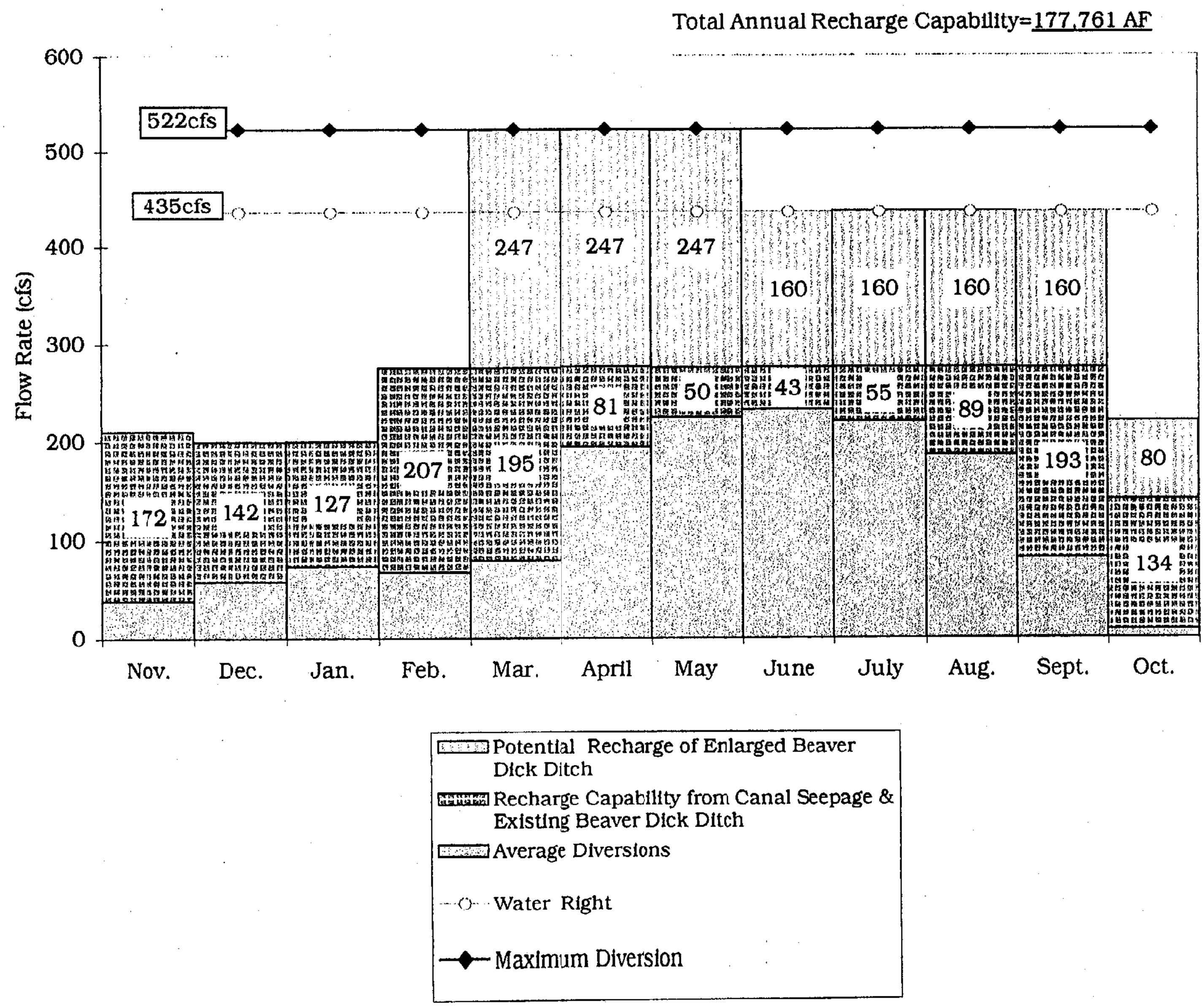

Figure A-5. Estimated Recharge Capability of Independent Canal.

tied or cross-connected among each of the canals at several points throughout the overall system. (An exception is the lower portion of the Last Chance Canal. It can only be cross-tied to the St. Anthony Canal; not vice-versa.) This somewhat unique feature of the overall system of canals allows for flexibility and versatility of water management within the system.

Brief descriptions of each of the canal systems within the overall Egin Bench Canal service area are discussed separately below. An overview of the canal systems and general service areas is shown in Figure A-6.

Last Chance Canal

The Last Chance Canal diverts water from the Henrys Fork of the Snake River at a point near the Chester Dam (T8N, R41E, Sec. 14), which is upstream from St. Anthony approximately six miles from where the Henrys Fork passes through St. Anthony. At a point approximately one-half mile north of St. Anthony (T8N, R40E, Sec. 36 and T8N, R41E, Sec. 31) the lower portion of the canal can be cross-tied into the St. Anthony Canal using a series of gates and checks referred to as the Junkyard Diversion. Flow can only be accomplished from the St. Anthony Canal to the lower portion of the Last Chance Canal downstream of the diversion. Opposite flow, from the Last Chance Canal to the St. Anthony Canal, is not possible because of the gradient.

Flow in the Last Chance Canal essentially skirts the sagebrush and sand dunes that form the northern boundary of arable land in the St. Anthony area. The canal supplies water to the northern portion of farm land in the irrigation service area. The canal runs to the west of St. Anthony for approximately five miles and discharges any returns into a depression near Davis Lake (T8N, R40E, Sec. 31).

Last Chance Canal is capable of diverting up to 135 cfs. At the point below the Junkyard Diversion the system is capable of carrying an additional 100 cfs by way of diversions from the St.

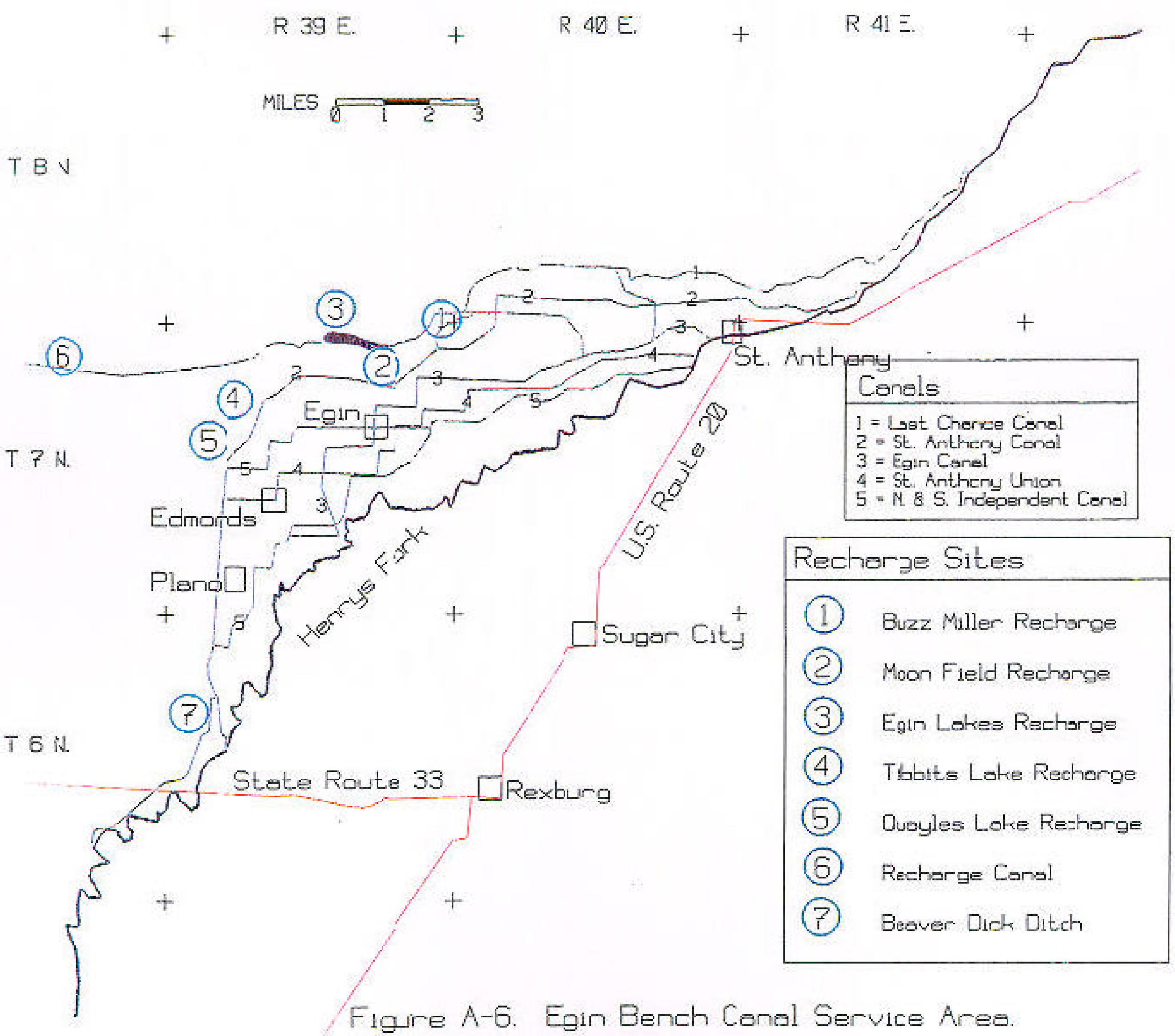

Figure A-6. Egin Bench Canal Service Area.

Anthony canal. However, the upper portion of the Last Chance Canal, from Chester to the Junkyard Diversion, can typically carry a maximum flow rate of about 135 cfs.

St. Anthony Canal

The St. Anthony Canal is the next canal encountered in the system when moving from north to south in the irrigation area. This is a relatively large and extensive canal. It can be cross-tied among the other canals at various points in the irrigation service area. Diversion from the Henrys Fork into the St. Anthony Canal takes place at a point on the Henrys Fork approximately three miles above St. Anthony (T7N, R41E, Sec. 33) near the Fun Farm. From the diversion the canal runs approximately a mile north of St. Anthony and through the farmland to the west for approximately five miles. At this point (T8N, R40E, Sec. 31), about one-half mile southeast of Davis Lake, the canal turns abruptly to the south and begins to generally run to the southwest for approximately six miles to a point just to the southeast of Quayles Lake (T7N, R39E, Sec. 20). From there the canal runs due south to a point near the confluence of the Henrys Fork and the South Teton River (approximately five miles) before returning to the Henrys Fork at a point (T6N, R39E, Sec. 20) about three-quarters of a mile northeast of the North Fork Bridge over the Henrys Fork on State Highway 33.

At the point just southeast of Davis Lake (T8N, R40E, Sec. 31), mentioned above, a set of gates and checks allows for diversion of approximately 300 cfs to the area in the vicinity of Egin Lakes to the west; and further west for four or five miles to depressions in the sand dunes and sage brush on Bureau of Land Management (BLM) ground in an area (T7N, R38E, Sec. 12) approximately one mile northeast of Ninemile Knoll (T7N, R38E, Sec. 15). This diversion is capable of providing a relatively large amount of artificial recharge year-round. This will be discussed in further detail in a following section of this report.

The St. Anthony Canal is capable of carrying 600 cfs. However, the combined water right for both the St. Anthony Canal and the St. Anthony Union Canal (to be discussed below) is 724 cfs. Thus, flows in these two systems (St. Anthony and St. Anthony Union) must be managed conjunctively.

There is a ditch located on the bottom end (or south end) of the St. Anthony Canal system (T6N, R39E, Sec. 17 & 18) referred to as the "Beaver Dick Ditch". This ditch is currently used by the Cartier Ranch and the Idaho Fish and Game. The diversion point from the canal to the ditch consists of a 30-inch galvanized pipe. The ditch runs for approximately one-quarter mile to the west and then turns and generally runs to the southwest for approximately three miles, where the ditch returns flow to the Cartier Slough near the Henrys Fork (T6N, R38E, Sec. 35). The recharge potential of the Beaver Dick Ditch is assigned to Independent Canal, even though the other canals in the system may be cross-linked to supply Beaver Dick Ditch.

Egin Canal

The Egin Canal, with a capacity of about 420 cfs, generally runs south of the St. Anthony Canal. The Egin Canal diverts water from the Henrys Fork (T7N, R40E, Sec. 1) near the middle of the city of St. Anthony near what is called Island Park, a local recreation area. The canal generally parallels the Henrys Fork for approximately eight miles to the southwest to a point (T7N, R39E, Sec. 14) near the town of Egin where the canal turns generally south and flows for approximately four miles to a point (T7N, R39E, Sec. 27) near the confluence of the Henrys Fork and Teton Rivers. From here the canal follows the high ground adjacent to the river for approximately one mile before returning to the river.

There is a check structure in the bottom (south end) of the Egin Canal system (T7N, R39E, Sec. 28) that can be used to divert flow from the Egin Canal to the lower portions of the Independent and, ultimately, the St. Anthony Canal systems.

St. Anthony Union Canal

The St. Anthony Union Canal generally runs southwest from St. Anthony between the Egin Canal and the Independent Canal. Diversion for the canal takes place on the Henrys Fork at a diversion dam located approximately one-half mile downstream from the diversion for the Egin Canal (T7N, R40E, Sec. 1). Again, the diversion is located essentially in the city of St. Anthony. From the diversion the canal generally parallels the river to the southwest for approximately ten miles where it joins the lower end of the St. Anthony Canal at a point (T7N, R39E, Sec. 29) approximately one mile south of Quayles Lake.

St. Anthony Union Canal is capable of carrying approximately 250 cfs. However, it shares water rights with the St. Anthony Canal. Therefore, between the two systems the aggregate right is 724 cfs; although, individually, the canals are capable of carrying a total flow of approximately 860 cfs.

The maximum flow observed between 1980 and 1994 for this canal is 259 cfs in June 1, 1981. The Watermaster pointed out that at present normal flow is nearly half that amount because there is no longer a high-volume requirement during spring to raise the water table for sub-irrigation as there was in the past.

Independent Canal

The Independent Canal is the southernmost canal in the Egin Bench Canal system and consequently is the closest to the Henrys Fork River. It diverts flow from the north side of the Henrys Fork at a point approximately one-half mile downstream of the St. Anthony Union Canal diversion point. The canal generally parallels the Henrys Fork for approximately six miles to the southwest, then splits into a north and south branch at a point (T7N, R39E, Sec. 13) approximately one mile due east of the town of Egin. The north branch runs west for three miles through the town of Egin and then turns generally southwest for two miles where it returns to the St. Anthony Canal at a point (T7N, R39E, Sec. 20) approximately one-half mile southeast of Quayles Lake. The south branch generally runs parallel to the Henrys Fork to the southwest for approximately six miles where it returns to the lower portion of the St. Anthony Canal at a point (T6N, R39E, Sec. 7) approximately four miles due south of Quayles Lake.

Independent Canal is capable of carrying approximately 500 cfs. The water right for this canal is 435 cfs. The north branch generally carries approximately 30% of the canal flow, while the south branch carries 70%.

System Description

The lower portions of the St. Anthony, Egin, St. Anthony Union and Independent Canals contain a number of emergency turnouts or spillways back to the Henrys Fork or adjacent sloughs. There are no lift pumps located in any of the canal systems in the service area. Very little flood irrigation occurs anywhere in the system. Most farmers pump from the canals or laterals and irrigate with center pivots. There are a few wheel lines and hand lines in the system, but they are rare and used mostly to irrigate corners of the pivot system fields.

Twenty years ago most of the Egin Bench area was irrigated by recharging ground water and thus saturating the root zone through "sub-irrigation". Today most of the Egin Bench area is irrigated with center pivot irrigation systems.

Most of the Egin Bench Canal system is located in 20- to 30-foot thick deposits of sand, some gravel and silty sands. Thus, the system undergoes considerable leakage early each season and then leakage subsides as the season progresses. However, the sandy nature of the area provides benefit in that the canals can be filled in the early winter, allowed to freeze on the surface of the water, then canal level lowered once the original water surface has frozen. In this way, the canals can be operated in a recharge mode all winter under the frozen surface. This type of winter recharge, where canal leakage is taking most of the water, has been practiced successfully since 1885.

St. Anthony Union

Actual recharge capability of the St. Anthony Union Canal is assumed by the Watermaster to be approximately one-half of the maximum flow. Even though much of the canal system runs in proximity to the river (usually within one mile), the Watermaster believes that most, if not all, recharge from the canal will flow towards the southwest rather than return to the river.

Like the Egin Canal, there are not many available locations for artificial recharge in the system proper. However, like the Egin Canal, the St. Anthony Union Canal can be connected to the Beaver Dick Ditch via the St. Anthony Canal. This adds some capacity for recharge outside of normal seepage. Currently, the Watermaster estimates **recharge potential of the St. Anthony Union Canal to be approximately 50 cfs.**

Independent

Most of the recharge potential in the Independent Canal is from canal seepage. Some seepage is expected to return to the river (see discussion above), but most is expected to flow away from the river to the southwest. Like the Egin and St. Anthony Union systems, there is little opportunity in the system for additional recharge. Similarly, the Independent Canal flow can be directed to the Beaver Dick Ditch via the lower end of the St. Anthony Canal. Current estimates of recharge potential for the Independent Canal appear to be no more than 300 cfs, of which a significant percentage (some estimates are as high as 30%) is expected to return to the river. Discussions with the Watermaster to take into account these potential losses from the recharge capability of the canal have resulted in estimates of **recharge potential for the Independent Canal, including Beaver Dick Ditch, of approximately 300 cfs.**

The recharge potential of 245 cfs for the Independent Canal system includes credit for flows of up to 247 cfs in the Beaver Dick Ditch. (Note: The value of 245 cfs used in this discussion is rounded from 247 cfs, which appears in Figure A-5.) The current configuration of the ditch will not sustain flows of this magnitude. In order to carry flows near 250 cfs the ditch would have to expanded. However, the corporation feels that with an investment of less than $10,000, this expansion is possible. Therefore, for purposes of this study, the corporation is given credit for a flow capability of up to 247 cfs down the Beaver Dick Ditch. Inspection of Figure A-5 reveals how this added capacity is considered in the study.

There is another point to consider with regard to the flows shown in Figure A-5. Although several canals are capable of providing flow to the Beaver Dick Ditch via cross-cuts and interconnections among the various canals located at the lower end of the Egin system (these capabilities are discussed earlier), credit for recharge using these cross-connection capabilities is only taken in the Independent Canal hydrograph. This ensures that recharge capacity for a given canal system that is diverted to the Beaver Dick Ditch through the system of inter-ties in the lower Egin system is only credited once in the study. The accounting takes place in the Independent Canal hydrograph. Thus, Figure A-5 assigns recharge potential of the Beaver Dick Ditch to the Independent Canal even though other canals in the Egin system may be cross-connected into the Beaver Dick Ditch.

Summary

In summary, the total potential for artificial recharge, given the current structure of the Egin Bench Canal system, is shown in the following table. These values represent approximate annual average recharge flow rates for each of the canals in the Egin system.

Canal	Potential cfs
Last Chance	50
St. Anthony	200
Egin	80
St. Anthony Union	50
Independent	300
Total:	**680**

The highest potential for consistently achieving these flows occurs during the regular irrigation season and one month on either side of the season. Flows are expected to be substantially less during winter months.

IV. Description of Problems Implementing Artificial Recharge

Since the area has a history of conducting artificial recharge, few problems are expected. Icing can create problems, if the system is not carefully managed. However, years of experience in winter operation minimizes the likelihood of development of any significant problems associated with winter recharge activities. The upper end of the Last Chance Canal system cannot be recharged in the winter because the canal freezes from the bottom in that section. The Watermaster claims this is a result of the canal passing through basalt flows; which have different heat transfer characteristics from the sands, gravels and silty sands in the lower service area.

However, from March through November the upper system should be capable of approximately 50 cfs of recharge.

There is a maintenance period observed for the entire Egin Bench Canal system during the end of the growing season. However, this period is short (normally two weeks and seldom more than three) and occurs during the first of October. Following maintenance, the entire Egin Bench Canal system is refilled.

Only one potentially significant problem was mentioned several times during our interview. If the corporation were to expand capability to areas on public land outside of the service area boundary, it would be very important to coordinate strategies with the BLM. Apparently, the BLM is responsible for most of the land where viable recharge sites exist.

V. Conclusions

Egin Bench Canal Incorporated has a relatively long history of conducting recharge activities year-round in the Upper Snake River Valley. This experience, combined with a very favorable hydrogeologic setting for the canals in the service area, creates a significant potential for expanding artificial recharge activities in the area north and west of the Egin Bench. Currently, **the Egin Bench Canals corporation has potential of approximately 700 cfs of recharge.** With moderate expense and minor changes in system operation and design, this capability could be significantly increased.

APPENDIX B

New Sweden Irrigation District

This report is the result of May 16, 1996, discussions between the New Sweden Irrigation District manager, Paul Berggren; and Gary Johnson, Walt Sullivan and Jason Casper of the University of Idaho. This report discusses the operations of the New Sweden Irrigation District and artificial recharge opportunities of the company.

I. System Operations

I.A Water Rights

New Sweden Irrigation District holds 28 water rights which total 1076 cfs (Figure B-1). The water rights include diversions for several private canals that depend on New Sweden to convey their water, even though they are not shareholders in the company.

The New Sweden Company owns 92,635 AF of storage distributed between Palisades, Jackson Lake and American Falls Reservoirs (Table B-1).

Table B-1. New Sweden Irrigation District storage contracts

Reservoirs	Storage (AF)
Palisades	42,829
Jackson Lake	22,516
American Falls	27,290

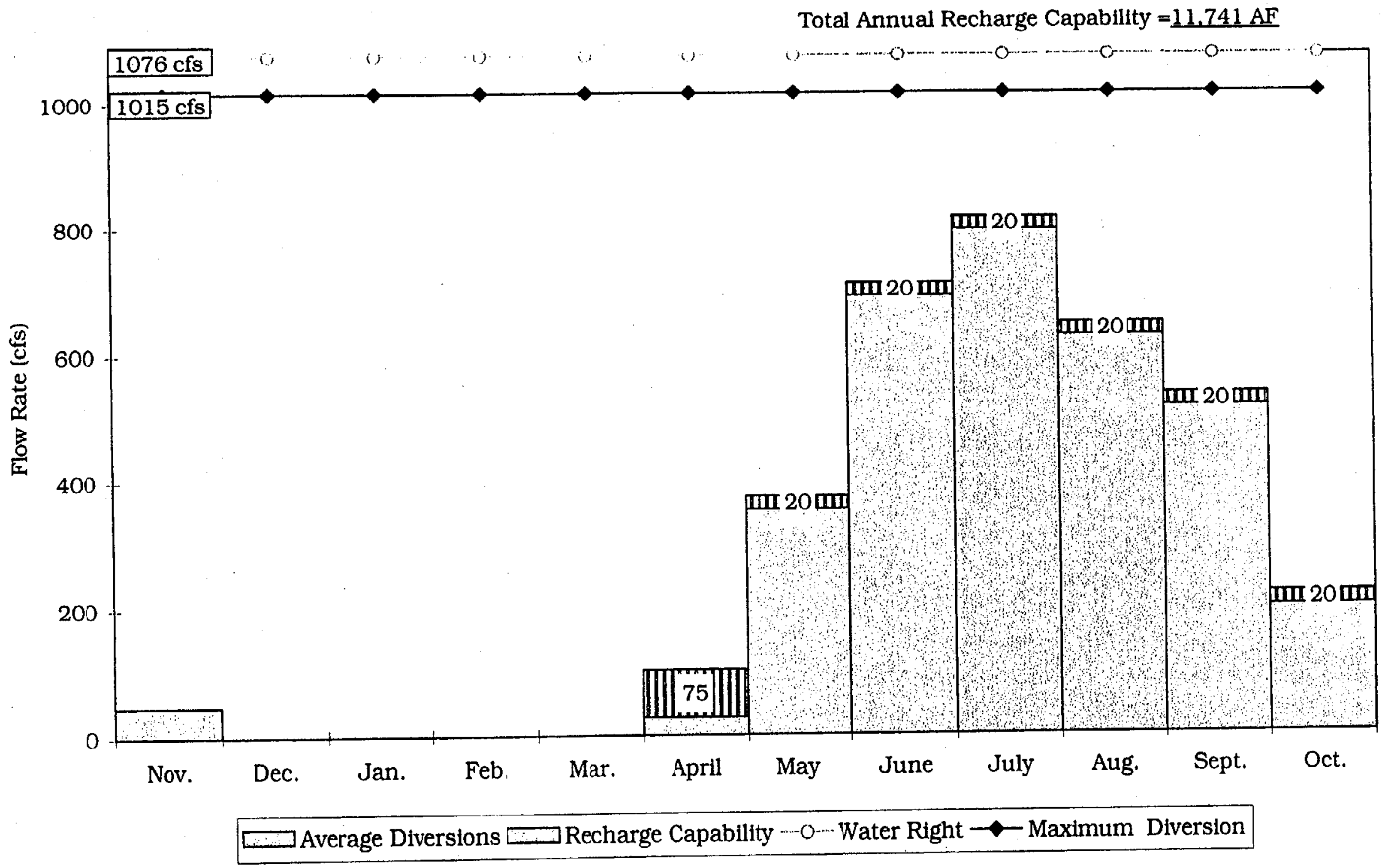

Figure B-1. Estimated Recharge Capability of New Sweden Irrigation District.

I.B Average Diversion Rate

Average monthly diversion rates were determined from the Water District No.1 Annual Reports. Diversions into the New Sweden Canal system are measured in each of the two main canals that divert from the Snake River, the Great Western and the Porter. The measured diversions also include water conveyed by these two canals to independent users (not shareholders). The diversion rates represent monthly average diversions for the fifteen-year period from 1980 to 1994. The average combined rates of Great Western and Porter Canals are presented in Table B-2, and presented graphically in Figure B-1.

Table B-2. Average Monthly Diversion Rates (1980 - 1994)

Month	cfs
November	47
December	0
January	0
February	0
March	0
April	28
May	354
June	690
July	796
August	626
September	516
October	200

I.C Physical Description of the System

A simplified map of the New Sweden Irrigation District canal system is provided in Figure B-2. This map shows the general orientation of the system as well as the location of the site that could be used for artificial recharge.

The New Sweden Irrigation District services approximately 31,000 acres of land to the west of the Snake River near Idaho Falls. Approximately 85 to 90% of the New Sweden service area is sprinkler irrigated. The New Sweden Irrigation District carries water for about 5,000 to 6,000 additional acres of land not in the watering district.

The Great Western and the Porter canals are the only canals in this system that divert water directly from the Snake River. The Great Western Canal diverts just east of Osgood and north of County Line Road (T4N., R37E., Sec. 35). The measuring station for Great Western Canal is at a point between West River Road and railroad bridge (T3N., R37E., Sec. 13). There is an emergency spill located at the top of the system that is capable of allowing the District to dump the whole Great Western canal back into the river (T3N., R37E., Sec. 13). Porter Canal diverts just east of the north end of the Idaho Falls airport (T2N., R37E., Sec.12). The measuring station on the Porter Canal is near the Farm Bureau offices, just south of John's Hole Bridge in Idaho Falls, ID (T2N., R37E, Sec. 12).

The Porter Canal divides into the Porter and the Sidehill Canal just to the west of Idaho Falls, ID (T2N., R37E., Sec. 25). The Porter and Great Western Canals combine approximately 3 miles north of Woodville (T2N., R37E., Sec. 30). The combination of the Great Western and Porter Canals dump into the New Lavaside Canal at a point approximately 2 miles north of Kimball (T1S., R36E., Sec. 32). The Sidehill Canal returns to the Snake River approximately 2 miles to the west of Shelley (T1N., R36E., Sec. 36).

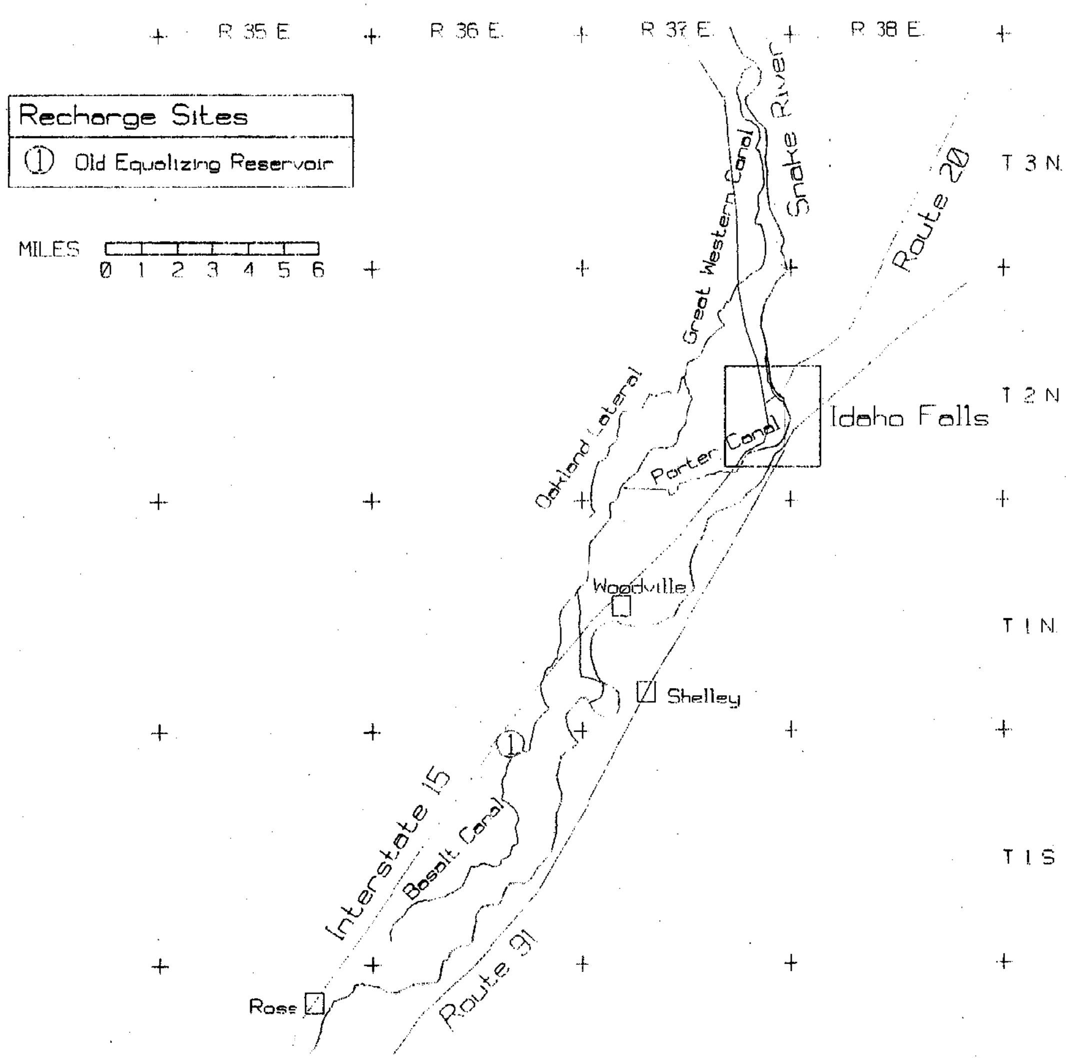

Figure B-2. New Sweden Irrigation District Canal System.

I.D Maximum Capacity

The maximum diversion capacity of New Sweden Irrigation District is estimated as 1015 cfs. This rate was determined as the sum of maximum daily flows for the Great Western and Porter Canals during the period 1980-1994 (Water District No. 1 Annual Reports). For Porter Canal the highest diversion (377 cfs) occurred on July 5, 1980, and for Great Western Canal the highest diversion (638 cfs) occurred on June 21, 1980. Capacity of both canals progressively decreases downstream as water is diverted for irrigation.

II. Artificial Recharge Experience

Artificial recharge was first practiced by the New Sweden Irrigation District in 1995. New Sweden Canal diverted water into their canals early and dumped water into an obsolete regulating reservoir (T1S., R36E., Sec. 11). In 1995, New Sweden Irrigation District recharged an estimated 9,896 AF (Carlson, 1996) into this site.

III. Assessment of Potential for Artificial Recharge

The potential for artificial recharge has been demonstrated in 1995 with two mechanisms:

1) The old equalizing reservoir, approximately 3 miles north of Firth (T1S., R36E., Sec. 11), and through
2) Canal seepage during non-irrigation season.

The existing canal system is constructed largely in permeable lava beds and consequently has relatively high rates of seepage. Transmission losses are estimated to be 30 to 35% of flow rates, possibly exceeding 200 cfs during high flows. Recharge by seepage can be accomplished during the non-irrigation season. Maintenance must also be performed during this time. Alternate year maintenance on each canal may provide greater opportunity for non-irrigation season recharge.

An old equalizing reservoir is located off the Great Western Canal approximately 3 miles above the town of Firth, ID. The reservoir was originally used for regulating canal flows. However, it is currently not in use because of high seepage in the reservoir due to the presence of large sink holes. As much as 20 cfs can be recharged at this site. Upstream canal capacity is sufficient to permit running 20 cfs into this site even during the peak months of irrigation. Opportunities for enlarged capacity for the reservoir exist. With a minimum amount of construction, sink holes plugged in prior maintenance practices could be reopened.

Recharge potential for New Sweden Canals is illustrated in Figure B-1. The stacked bar graph shows a potential recharge of 20 cfs throughout the irrigation season. This recharge is associated with flooding of the old reservoir. An additional 55 cfs recharge is anticipated in April by turning water into the canals earlier.

IV. Description of Problems Implementing Artificial Recharge

There are several issues that could constrain artificial recharge in the New Sweden Canal service area. Maintenance needs, Bureau of Reclamation restrictions, liability for running the canals in the non-irrigation season, and adverse weather generally comprise those constraints.

Canal system maintenance is performed as soon the canal is accessible in the fall and spring. However, it may be possible to perform maintenance on an alternating schedule between the two canals. In this case, while maintenance is performed on one canal the other could be used to convey recharge water. In this scenario, recharge can be implemented in the non-irrigation season in at least half of the system. This concept was not used in developing the recharge estimates projected in Figure B-1, because the canal manager was reluctant to commit to this practice as a permanent operating policy, at this time.

The Bureau of Reclamation currently prohibits diversion during 5 months of the year (i.e., November through March). These restrictions would have to be eased or removed in order for the District to be able to operate during the non-irrigation months.

Winter operation is limited because ice may damage canal components. In addition, ice formation in the system could cause flooding in adjacent populated areas due to ice jams that may result during late winter and early spring thaws.

Liability for keeping water in the canal year round may be a major constraint. This canal system runs through populated areas of Idaho Falls, ID, and consequently is likely to be impacted more by liability than other canal systems.

V. Conclusions

In 1995, the company participated in the state's initial attempt to execute an artificial recharge program in the eastern Snake River Plain. Artificial recharge is possible in the New Sweden Irrigation District area from April through November, by flooding an unused regulating reservoir and through canal seepage. With some limited modification to the regulating reservoir, the artificial recharge capability may be increased. The limiting constraints for recharge capability are maintenance needs, Bureau of Reclamation contract restrictions, liability and winter conditions. Adverse impacts associated with artificial recharge at any of the sites are expected to be minimal.

APPENDIX C

New Lavaside Ditch Company

This report is the result of April 30, 1996, discussions between New Lavaside Ditch Company Manager Lyle Lindsay; and Gary Johnson, Walt Sullivan and Jason Casper of the University of Idaho. This report discusses the operations of the New Lavaside Ditch Company and artificial recharge opportunities for the company.

I. System Operations

I.A Water Rights

The New Lavaside Ditch Company holds five water rights (Table C-1) totaling 192 cfs (Figure C-1).

Table C-1. Water Rights for New Lavaside Ditch Company

Flow (cfs)	Priority Date	Use
20	June 1, 1884	Irrigation and other purposes
60	March 1, 1889	Irrigation and other purposes
72	November 24, 1890	Irrigation and other purposes
30	January 22, 1916	Irrigation
20	November 1, 1984	Stock water

The company owns 11,750 acre-feet of storage in Palisades Reservoir. Approximately 50% of the New Lavaside service area is flood irrigated and 50% is sprinkler irrigated. There are two ground water wells located in the New Lavaside service area (T2S., R35E, Sec 11&12) near the town of Rose. These two wells provide water for about 80 acres of land.

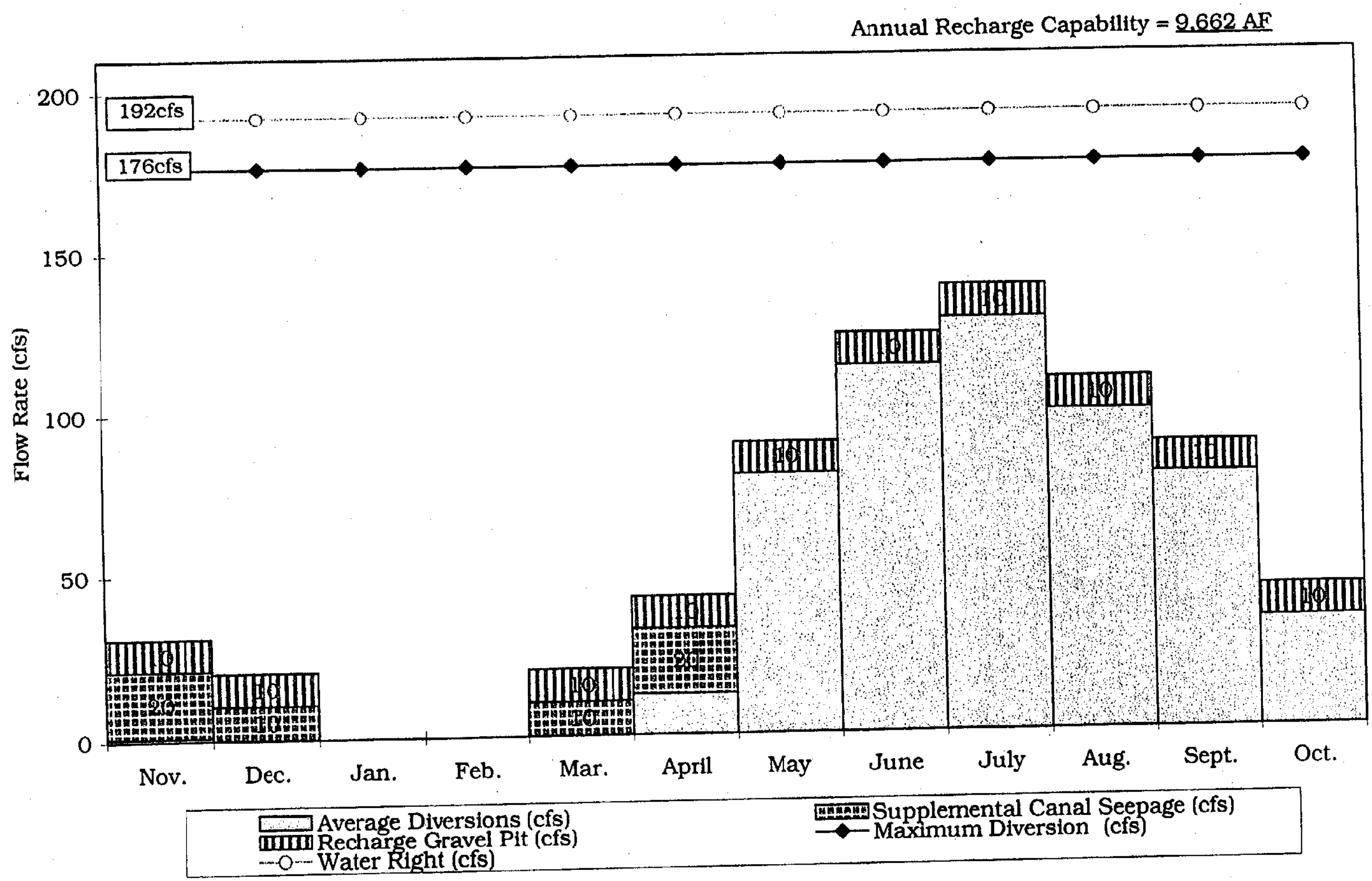

Figure C-1. Estimated Recharge Capability of New Lavaside Ditch Company.

I.B Average Monthly Diversion Rate

Average monthly diversion rates were determined from Water District No.1 Annual Report statistics for the canal company. The diversion rates represent monthly average diversions for the fifteen year period from 1980 to 1994. These average rates are summarized in Table C-2 and shown graphically in Figure C-1.

Table C-2. Average Monthly Diversion Rates (1980 - 1994)

Month	cfs
November	1
December	0
January	0
February	0
March	0
April	12
May	80
June	113
July	128
August	99
September	79
October	33

I.C Physical Description of the System

A simplified map of the New Lavaside canal system is provided in Figure C-2. This map shows the general orientation of the system as well as the location of the site that could be used for artificial recharge.

Anthony canal. However, the upper portion of the Last Chance Canal, from Chester to the Junkyard Diversion, can typically carry a maximum flow rate of about 135 cfs.

St. Anthony Canal

The St. Anthony Canal is the next canal encountered in the system when moving from north to south in the irrigation area. This is a relatively large and extensive canal. It can be cross-tied among the other canals at various points in the irrigation service area. Diversion from the Henrys Fork into the St. Anthony Canal takes place at a point on the Henrys Fork approximately three miles above St. Anthony (T7N, R41E, Sec. 33) near the Fun Farm. From the diversion the canal runs approximately a mile north of St. Anthony and through the farmland to the west for approximately five miles. At this point (T8N, R40E, Sec. 31), about one-half mile southeast of Davis Lake, the canal turns abruptly to the south and begins to generally run to the southwest for approximately six miles to a point just to the southeast of Quayles Lake (T7N, R39E, Sec. 20). From there the canal runs due south to a point near the confluence of the Henrys Fork and the South Teton River (approximately five miles) before returning to the Henrys Fork at a point (T6N, R39E, Sec. 20) about three-quarters of a mile northeast of the North Fork Bridge over the Henrys Fork on State Highway 33.

At the point just southeast of Davis Lake (T8N, R40E, Sec. 31), mentioned above, a set of gates and checks allows for diversion of approximately 300 cfs to the area in the vicinity of Egin Lakes to the west; and further west for four or five miles to depressions in the sand dunes and sage brush on Bureau of Land Management (BLM) ground in an area (T7N, R38E, Sec. 12) approximately one mile northeast of Ninemile Knoll (T7N, R38E, Sec. 15). This diversion is capable of providing a relatively large amount of artificial recharge year-round. This will be discussed in further detail in a following section of this report.

The St. Anthony Canal is capable of carrying 600 cfs. However, the combined water right for both the St. Anthony Canal and the St. Anthony Union Canal (to be discussed below) is 724

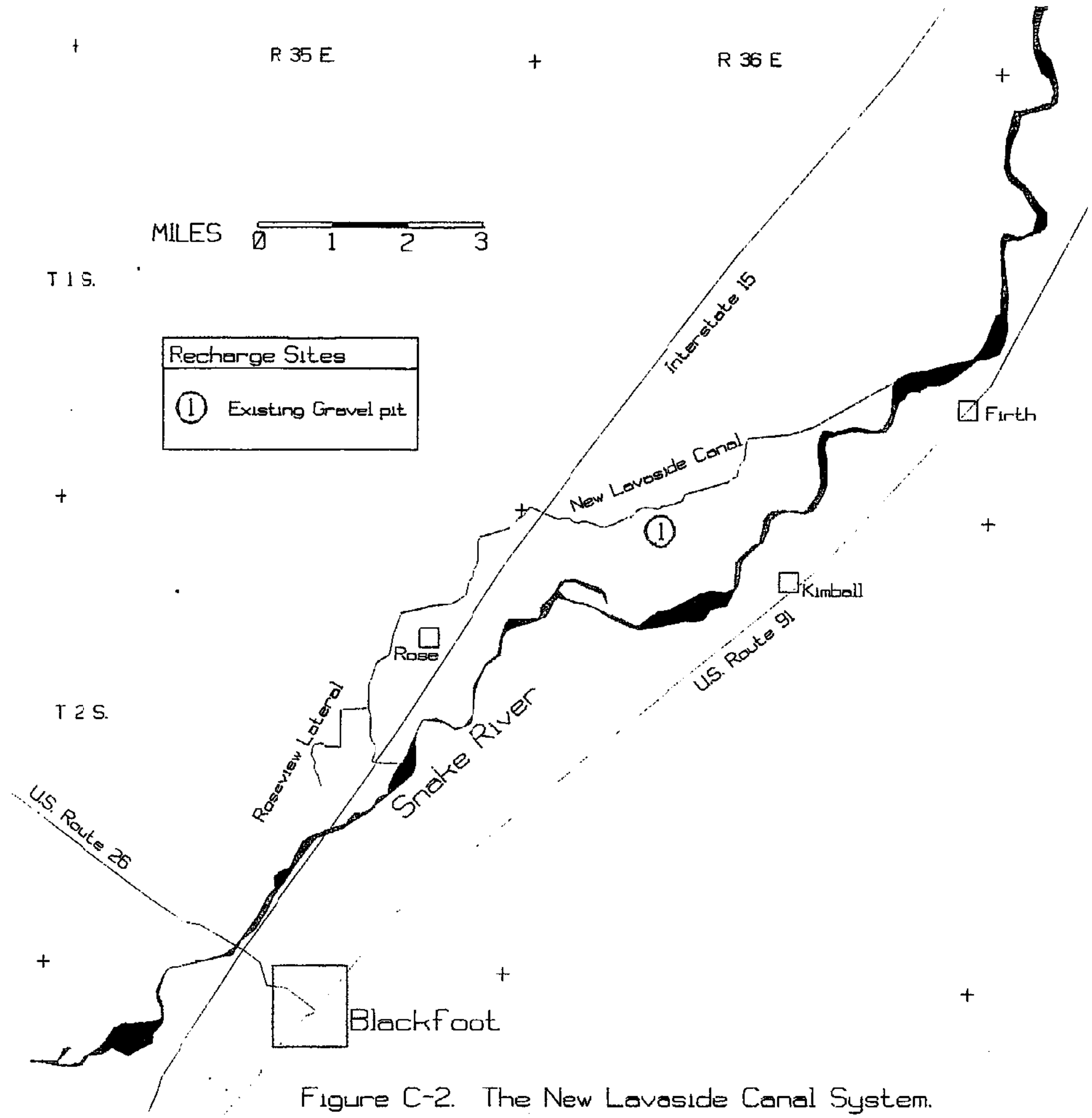

Figure C-2. The New Lavaside Canal System.

Diversions into the New Lavaside canal system begin at a point on the west side of the Snake River approximately one-half mile west of Firth, Idaho (T1S, R36E, Sec26). The diversion is shared by the Peoples Canal and the New Lavaside Canal. This common canal splits into the Peoples Canal and the New Lavaside Canal approximately 1 mile down stream from the Snake River diversion point (T1S, R36E, Sec27). A Hydromet station transmits diversion data from a broad-crested weir approximately a quarter of a mile down stream from the split (T1S, R36E, Sec27).

The first diversion into the New Lavaside service area occurs approximately one mile downstream from the broad-crested weir (T1S, R36E, Sec33). The total service area for the entire canal system is approximately 6,000 Acres. The entire service area is within a mile of the main canal and not more than two miles from the Snake River at any point throughout the service area, including a major lateral in the system known as the Roseview Lateral. The Roseview Lateral has a capacity of 60 cfs and can be used to spill as much as 40 cfs into the Riverside Canal. The Roseview Lateral diverts near the end of the canal system (T2S, R35E, Sec14).

The return spill to the Snake River for the New Lavaside system is located at the end of the canal system (T2S, R35E, Sec23), approximately three miles north of Blackfoot, Idaho. The return flows are maintained at approximately 6 cfs most of the irrigation season. The maximum return flow is not allowed to exceed 10 cfs.

There is flow variation of about 20 cfs in the canal system due to moss and weed intrusion. The company uses chemicals four times a year to effectively manage the growth and proliferation of plants in the system.

I.D Maximum Capacity

The maximum diversion capacity of the New Lavaside canal system is estimated as 176 cfs. This rate was determined as the maximum daily flow rate during the fifteen-year period of

1980 through 1994. The maximum diversion occurred on July 18, 1980. Capacity of the main canal decreases progressively downstream as water is diverted for irrigation. The main canal has a capacity of about 40 cfs where it returns to the Snake River.

II. Artificial Recharge Experience

Artificial recharge was first practiced in the New Lavaside canal system in 1995. New Lavaside diverted water into the system in early April of 1995 in an attempt to seep water from the canal for recharge purposes.

III. Assessment of Potential for Artificial Recharge

The potential for artificial recharge through canal seepage has been demonstrated, and may also be possible using an existing gravel pit located near the top of the canal system (T2S, R36E, Sec5). Thus there are two potential recharge sites in the New Lavaside canal system:

1) Seepage from the existing canals, and
2) An existing gravel pit, approximately two miles west of Kimball, Idaho (T2S, R36E, Sec5).

Seepage losses from the existing canal system can be used as a source of artificial recharge during the non-irrigation season. The estimated recharge rate associated with canal seepage is between 10 cfs and 20 cfs. Seepage in the canal is not expected to exceed 20 cfs. No recharge is anticipated in December or January due to the need to have the canal dry for maintenance and due to winter constraints.

The existing gravel pit is located approximately 60 to 100 feet from the main canal. With minimum construction, this site could be used for artificial recharge purposes. Because excess capacity exists in the canal up-stream from the first diversion, artificial recharge can be implemented even during the irrigation season. This gravel pit is relatively secluded. Consequently, few adverse impacts are expected from artificial recharge at this site. The gravel pit covers approximately 1 acre and is roughly 15ft deep. It is estimated that this site could receive continuous flow of up to 10 cfs since it is located in gravel deposits.

A monthly summary of diversions and recharge potential is provided in Figure C-1. The graph shows irrigation diversions (1980-1994 average) as the light shaded portion of the stacked bar graph. Irrigation diversions are apparent from April through October, and reach a maximum in July. Additional canal seepage is possible in the months of March, April, November, and December; and is shown by the vertically lined bar segments. Approximately 10 cfs of artificial recharge is possible in the gravel pit and is shown as the uppermost bar segment for the months of March through December. The recharge potential, from both supplemental canal seepage and from use of the gravel pit is estimated to be nearly 9,700 acre-feet per year.

IV. Description of Problems Implementing Artificial Recharge

There are several problems that could act as constraints for artificial recharge in the New Lavaside area. Maintenance needs, Bureau of Reclamation restrictions and weather generally define the constraints.

Canal system maintenance is performed during the non-irrigation months from November through March. Most maintenance is conducted in March. However, leaving the system dry through the winter minimizes mud in the canal bottoms and maximizes plant die-out in the canal.

The Bureau of Reclamation currently restricts diversion from November through March. These restrictions would have to be reduced or removed in order for the canal company to be able to operate during the non-irrigation season.

During winter, ice formation in the system could damage canal components. In addition, ice jams that may result during late winter and early spring thaws could cause flooding in adjacent areas.

V. Conclusions

In 1995, the company participated in the state's initial attempt to execute an artificial recharge program for the Upper Snake River Valley. Hence, the company has demonstrated recharge capability. Artificial recharge is possible in the New Lavaside system area during most of the months in the year. By increasing canal seepage during the non-irrigation season, and flooding an abandoned gravel pit, the company can artificially recharge up to 9,700 AF/year. Some additional work is needed to make the gravel pit a viable artificial recharge site. The limiting constraints for expanded recharge capability are maintenance needs, Bureau of Reclamation contract restrictions and winter conditions. Adverse impacts associated with artificial recharge at any of the sites are expected to be minimal.

APPENDIX D

Peoples Canal & Irrigation Company

This report is the result of May 2, 1996, discussions between the Peoples Canal & Irrigation Company manager, Cliff Merrill; and Gary Johnson, Walt Sullivan and Jason Casper of the University of Idaho. This report discusses the operations of the Peoples Canal Company and artificial recharge opportunities that may exist within the company.

I. System Operations

I.A Water Rights

Peoples Canal Company holds four water rights (Table D-1) totaling 624 cfs. This value is also displayed in Figure D-1, a summary of diversion rates and artificial recharge capacity for the company.

Table D-1. Water rights for Peoples Canal & Irrigation Company

Amount (cfs)	**Priority Date**
7.6	March 6, 1885
16.6	July 15, 1888
400	August 18, 1895
200	January 22, 1916

The company owns 76,435 acre-feet of storage in the upper Snake River system – 21,070 acre-feet in American Falls Reservoir; 35,000 acre-feet in Palisades Reservoir; and 20,365 acre-feet in Jackson Reservoir.

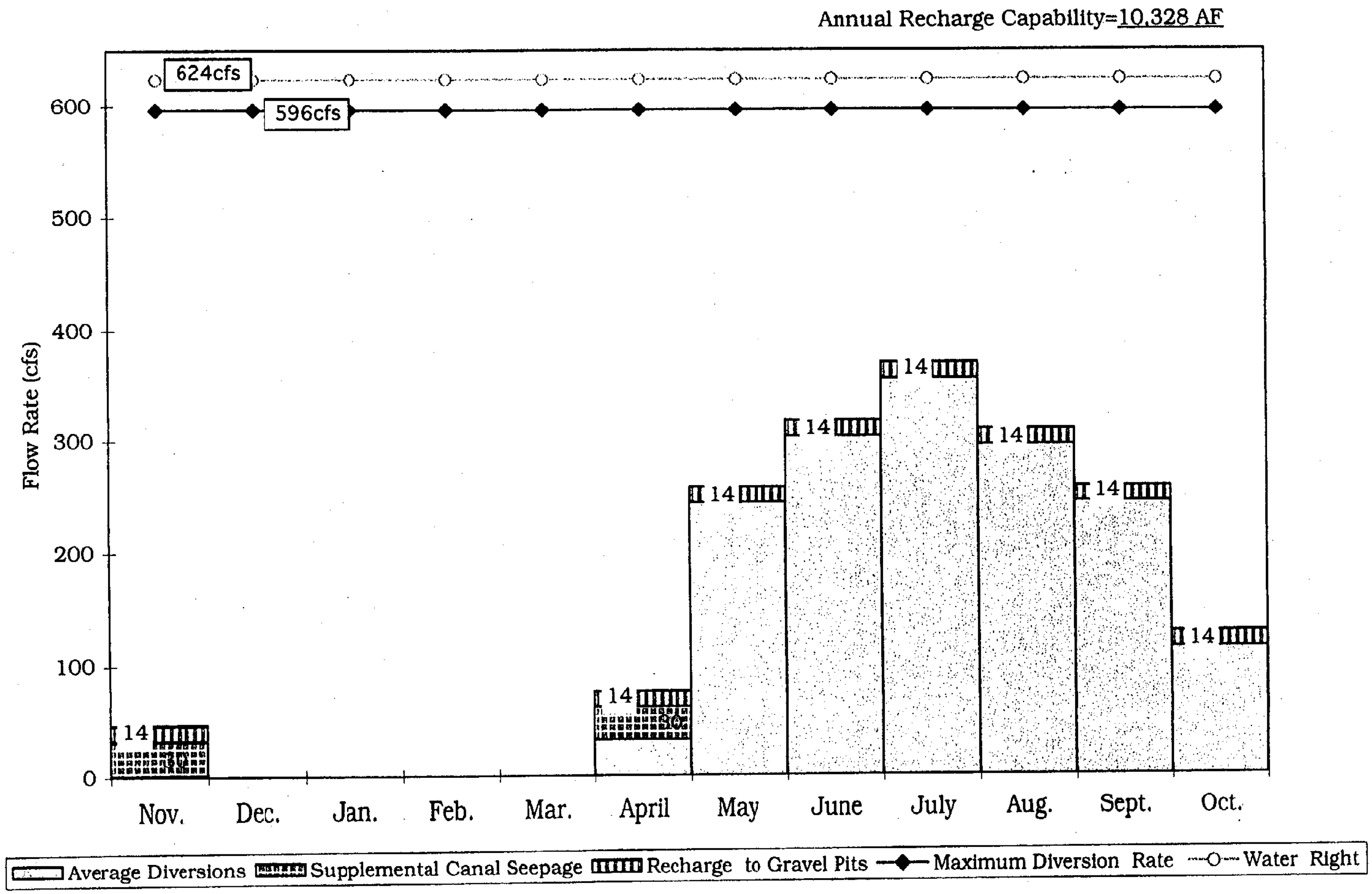

Figure D-1. Estimated Recharge Capability of Peoples Canal Irrigation Company.

I.B Average Diversion Rate (Monthly)

Average monthly diversion rates were determined from the Water District No.1 Annual Reports. Diversion rates presented in Table D-2 represent monthly average diversions for the fifteen-year period from 1980 to 1994. These average rates are also shown in graphical form in Figure D-1.

Table D-2. Average Monthly Diversion Rates (1980 - 1994)

Month	**cfs**
November	0
December	0
January	0
February	0
March	0
April	32
May	243
June	303
July	355
August	295
September	244
October	113

I.C Physical Description of the System

A simplified map of the Peoples canal system is provided in Figure D-2. This map shows the general orientation of the system as well as the location of the sites that could be used for artificial recharge.

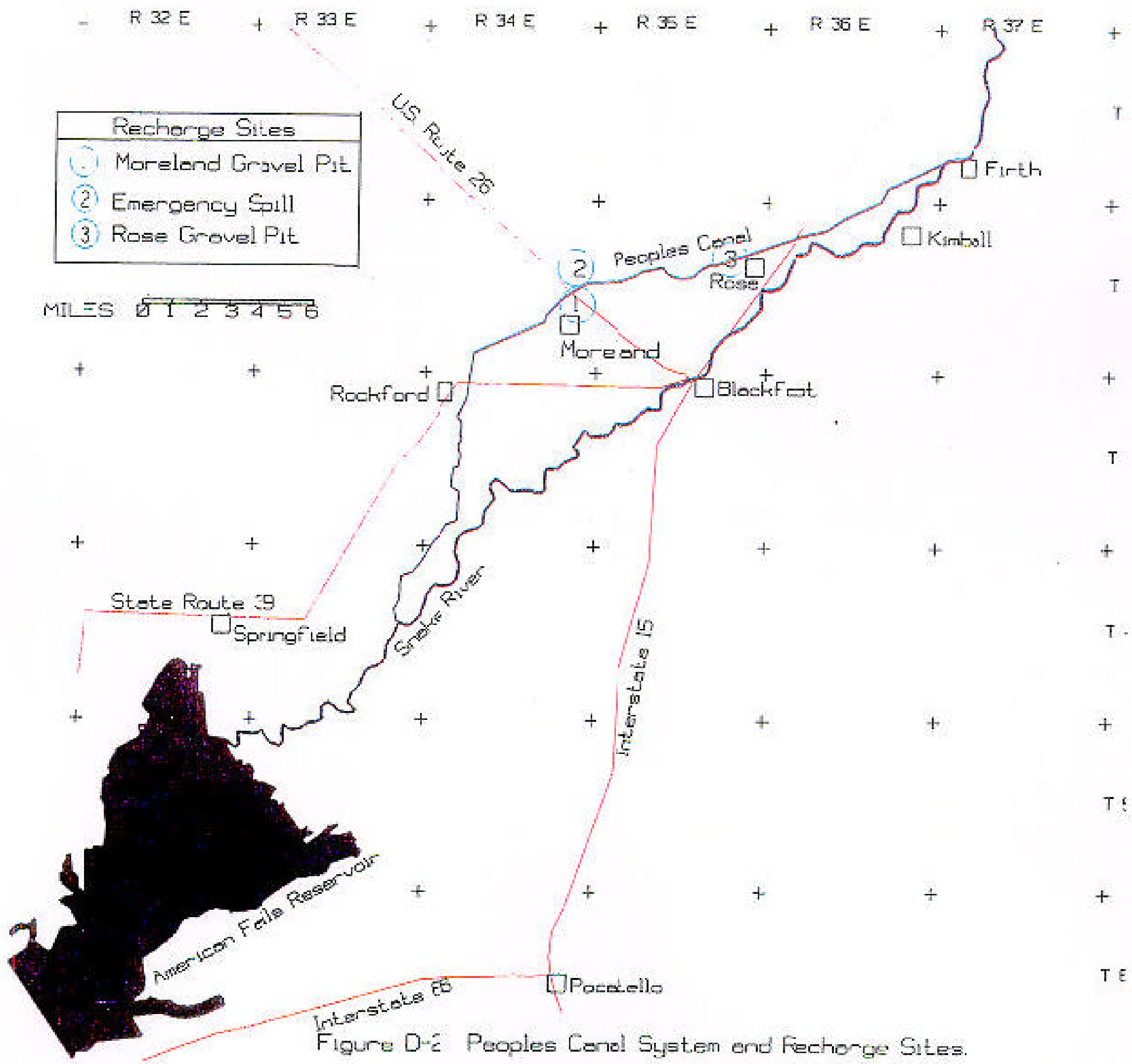

Figure D-2 Peoples Canal System and Recharge Sites.

Diversions into Peoples Canal Company system occur at a point on the west side of the Snake River approximately one-half mile west of Firth, Idaho (T1S, R36E, Sec26). The diversion is shared by the Peoples Canal and the New Lavaside Canal. This common canal splits into the Peoples Canal and New Lavaside Canal approximately one mile down stream from the Snake River diversion point (T1S, R36E, Sec27). A Hydromet station remotely transmits water flow measurements taken at a broad-crested weir (T1S., R36E., Sec. 27). This measurement point is approximately 200 yards down stream from the split with New Lavaside Canal.

The system includes 22 laterals and irrigates about 20,000 acres. Approximately 50% of the area is irrigated with center pivots, 15% with wheel lines and hand lines, and about 35% is flood or furrow irrigated. Laterals terminate with no return flow to the river, however, the main canal returns to the Snake River about 6 miles east of Springfield, Idaho (T4S, R33E, Sec14). Return flows in the main canal average about 10 cfs with some variation.

The system contains an emergency spill several miles downstream of the split with the New Lavaside, near were the Peoples Canal crosses under U.S. Route 26. A 40-inch head gate (T2S, R34E, Sec23) allows Peoples Canal to dump about 6 cfs into a depression which flows into the Hells Half Acre lava flows. However, use of the emergency spill for artificial recharge purposes is unlikely. Canal management reserves the excess capacity in the spill area for emergency diversion in case of a break or overfill in the lower canal system.

Peoples canal exhibits little or no variation in flows due to moss and weed intrusion. The company uses chemicals about three times a year to effectively manage the growth and proliferation of plants in the system.

I.D Maximum Capacity

The maximum diversion capacity of Peoples Canal Company is estimated as 596 cfs. This value was taken from annual Water District No.1 Watermaster Reports for the period from 1980 to 1994. This rate was determined as the highest daily flow rate during the 15-year period. For Peoples Canal the highest diversion occurred on July 11, 1981. However, the canal company manager believes actual capacity is less. Capacity of the main canal progressively decreases downstream as water is diverted for irrigation.

II. Artificial Recharge Experience

Artificial recharge was first practiced in Peoples Canal Company in 1995. Peoples Canal diverted water into their emergency spill in an attempt to seep water for artificial recharge purposes. The canal company did not receive credit from the Idaho Department of Water Resources for this attempt because of late submission of the application.

III. Assessment of Potential for Artificial Recharge

The potential for artificial recharge has been demonstrated through an emergency spill into Hells Half Acre lava flows. Opportunities also exist at two gravel pits in close proximity to the canal and through canal seepage. Thus, there are four potential recharge sites in the Peoples Canal system:

1) Gravel pit #1, approximately one-half mile north of Moreland, Idaho (T2S, R34E, Sec23).
2) Gravel pit #2, approximately two miles west of Rose, Idaho (T2S, R35E, Sec9).

3) Emergency spill, next to the Peoples Canal near U.S. Route 26 (T2S, R34E, Sec 14 & 23).

4) Canal seepage during non-irrigation season.

The existing canal system is constructed largely in coarse sediments and consequently has relatively high rates of seepage. Seepage rates are unknown, but are expected to be greater than 20 cfs. A seepage of 30 cfs will be assumed for this report. It is expected that this rate could be credited as recharge in April and November. During the irrigation season, the seepage occurs as a normal product of irrigation and is not considered as artificial recharge for the purposes of this report.

Gravel pit #1 is located next to the main canal (T2S, R34E, Sec23). With minimum construction, this site could also be used for artificial recharge purposes. The gravel pit is relatively secluded, consequently, few adverse impacts are expected from artificial recharge at this site. The gravel pit covers approximately 10 acres. It is estimated that this site could receive a continuous flow 10 to 12 cfs.

Gravel pit #2 is located next to the main canal (T2S, R35E, Sec9). With minimum construction, this site could be used for artificial recharge purposes. This gravel pit is relatively secluded, consequently, few adverse impacts are expected from artificial recharge at this site. The gravel pit covers approximately 2 acres and is roughly 15 ft deep. It is estimated that this site could receive a continuous flow of up to 2 cfs since it is located in highly permeable gravel deposits. The state is currently hauling gravel from this pit.

An emergency spill is located next to the Peoples Canal near U.S. Route 26 (T2S, R34E, Sec23). A 40 inch head gate controls flow to the emergency spill with a 48 inch culvert allowing flow to the east, underneath U.S. Route 26. The emergency spill allows water to flow into a depression near Hells Half Acre. As much as 6 cfs can be diverted into this site. Upstream canal capacity is sufficient to permit running 6 cfs into this site even during the peak months of irrigation. Enlarging this site to over 20 acres is possible with some construction. With enlargement, this area may seep up to 300 cfs, in which case upstream canal capacity may become the constraining feature.

IV. Description of Problems Implementing Artificial Recharge

Factors that could constrain artificial recharge in Peoples Canal service area include: Maintenance needs, contract restrictions with the Bureau of Reclamation, and winter weather conditions. Canal system maintenance is performed during March as soon the canal is accessible. Artificial recharge is therefore not possible until April 1 in most years. The Bureau of Reclamation currently prohibits diversion during 5 months of the year (i.e., November through March) under a contract for storage in Palisades Reservoir. These restrictions would have to be eased or removed in order for the canal company to be able to operate during the non-irrigation months. Winter operation is limited because ice may damage canal components. In addition, ice formation in the system could cause flooding in adjacent areas due to ice jams that may result during late winter and early spring thaws.

V. Conclusions

In 1995, the company participated in the state's initial attempt to execute an artificial recharge program in the eastern Snake River Plain. Additional recharge can be accomplished in the Peoples Canal Company area from April through November. Given current management restrictions on use of the emergency spill for artificial recharge, the company is given credit in this study for approximately 10,000 acre-feet of annual artificial recharge capacity. By flooding existing gravel pits and the existing emergency spill the company can artificially recharge up to 13,000 AF/year. With expansion of the emergency spill channel and recharge site, the artificial recharge capability may be increased to about 78,000 AF/year. Some construction and expense is needed to make the two gravel pits viable artificial recharge sites. The limiting constraints for recharge capability are maintenance needs, Bureau of Reclamation contract restrictions and winter conditions. Adverse impacts associated with artificial recharge at any of the sites are expected to be minimal.

APPENDIX E

Aberdeen-Springfield Canal Company

On March 13, 1996, Gary Johnson, Walt Sullivan and Jason Casper met with Mr. Charles (Chuck) Yost, General Manager of the Aberdeen-Springfield Canal Company, in Aberdeen, Idaho. Pertinent information gleaned from the meeting is summarized in the standard format being used to document findings of this study, below.

I. System Operation

I.A Water rights

The Aberdeen-Springfield Canal Company holds two water rights. The oldest priority is dated **February 6, 1895, for 1172 cubic feet per second (cfs)**. The junior right is dated **April 1, 1939, for 215 cfs**. Hence, the **total right** held by the company is **1387 cfs**. Mr. Yost confirmed these values. The total, 1387 cfs, is displayed in the graphic information that summarizes Aberdeen-Springfield Canal Company's diversion capabilities (provided as a separate chart in this report, Figure E-1).

I.B Average Irrigation Diversions

Average monthly diversion rates for the canal company were also discussed with Mr. Yost. These rates were derived from Water District No. 1 Annual Report statistics for the canal company. Fifteen years (1980 - 1994) of mean daily diversion rates, in cfs, were used to determine the average monthly diversion rates. For purposes of this study, the water year begins with the month of November and ends in the following calendar year with the month of October. This convention is used because the underlying data in the Watermaster Report are arranged in

Annual Recharge Capability =244,072 AF

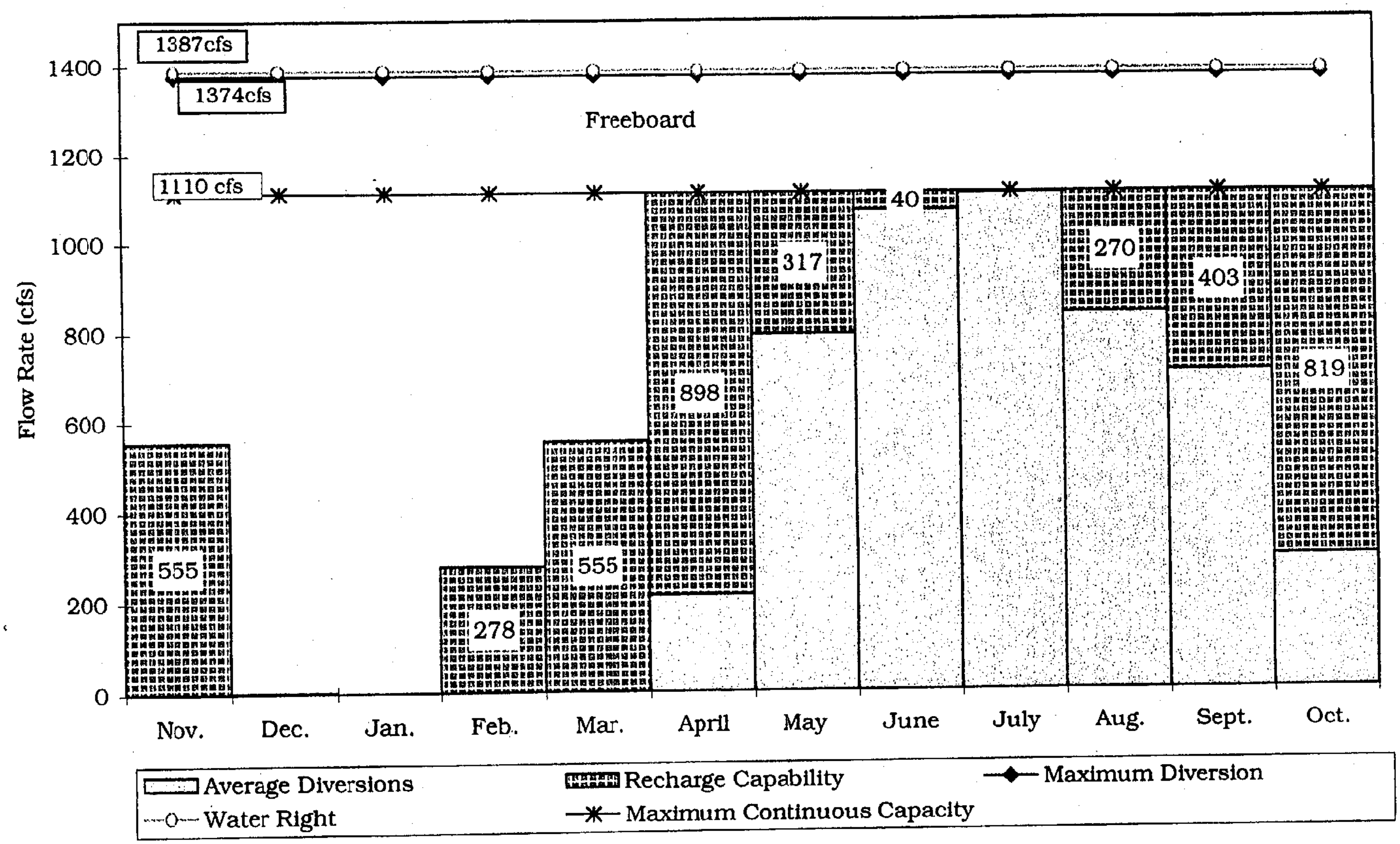

Figure E-1. Estimated Recharge Capability of Aberdeen-Springfield Canal Company.

this manner. The monthly rates were reviewed by Mr. Yost and confirmed as being representative for the company. The general results for Aberdeen-Springfield are given in Table E-1, below.

Table E-1. Average monthly diversion rates (1980 - 1994)

Month	cfs
November	0
December	1
January	0
February	0
March	0
April	212
May	793
June	1070
July	1107
August	840
September	707
October	291

I.C Physical Description of the System

A map of the Aberdeen-Springfield canal system is provided as Figure E-2. This map shows the general orientation of the system as well as the location of the sites that could be used for artificial recharge.

Diversions into the Aberdeen-Springfield canal system begin at a point on the west side of the Snake River approximately 2 miles southwest of Firth, Idaho (T1S, R36E, NE quadrant of Section 34). A Hydromet station remotely transmits total diversion into the system at a point

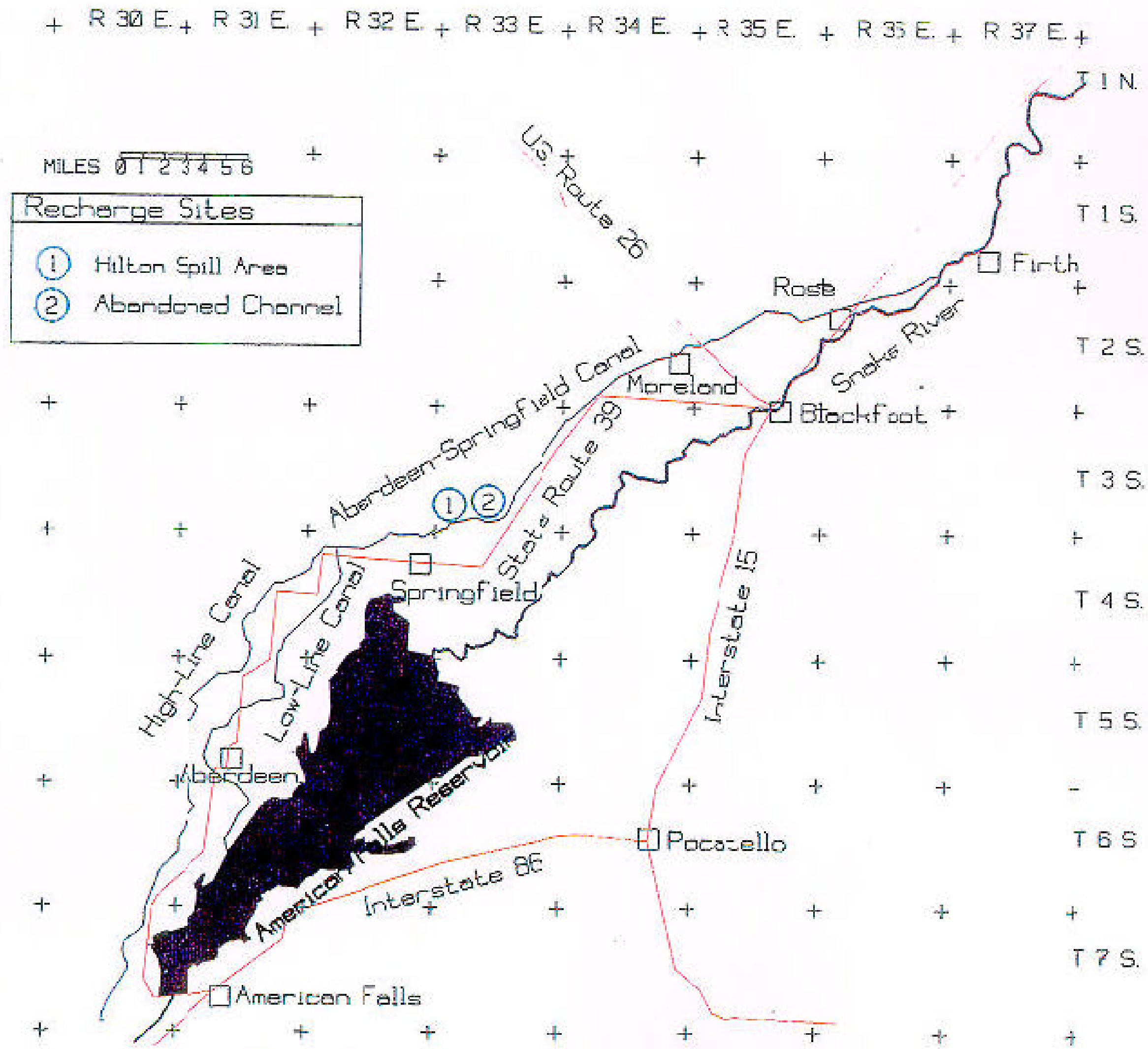

Figure E-2 The Aberdeen-Springfield Canal System.

approximately 2 miles downstream of the Snake River diversion point (T2S, R36E, roughly at the intersection point of Sections 4 and 5). The measuring station can be accessed from South Lavaside Road, a north-south road located approximately 4 miles southwest of Firth.

Numerous spills or return-flow sites exist throughout the system. Most are located in the lower sections of the system. Returns have been measured and recorded since 1992. The return volumes have historically varied from approximately 12,000 AF/year (12,127 AF in 1992) to over 36,000 AF/year (36,471 AF in 1995) (Aberdeen-Springfield Annual Report, 1995). Actual measurement frequencies to arrive at these yearly volumes are unknown. Specific measurement information was unavailable in the annual report; only aggregate volumes for each year are given.

Significant flow variations in the canal system due to mossing and weed intrusion are minimal or non-existent. The company uses chemicals to effectively manage the growth and proliferation of plants in the system.

I.D Maximum capacity

The maximum diversion capacity of the Aberdeen-Springfield canal system was assumed to be **1374 cfs**. This rate was determined by reviewing the daily maximums during the fifteen-year investigation period and choosing the highest daily flow rate during that time. For Aberdeen-Springfield the highest daily diversion occurred on July 2, 1980.

Mr. Yost generally agreed with this number, although he pointed out that he seldom diverted at rates in this range for any length of time. High diversion rates increase the likelihood of leaks in the canal system and flow damage to canal components. Mr. Yost believes a safe operating level in this system is about 1100 cfs. This rate will provide sufficient "freeboard" in the system to minimize hazards.

II. Artificial Recharge Experience

Artificial recharge was first practiced in the Aberdeen-Springfield canal system in 1995. Although the canal system typically sustains relatively high transmission losses (40 - 65%) (A-S Annual Report, 1995), only recharge into the Hilton Spill area was credited as managed recharge for the company in 1995. Recharge credit for the company in 1995 was 7,952 AF (Carlson, 1995).

The Hilton Spill area is located approximately 2.5 miles west of Pingree, Idaho (T3S, R33E, Section 31). According to Mr. Yost, the spill area is capable of receiving diversions of up 320 AF/day April through October. According to Carlson (1995), the average daily recharge during the artificial recharge period for Aberdeen-Springfield in 1995 (34 days in April and May) was 234 AF (118 cfs).

The Hilton Spill area occurs in a natural depression adjacent to the main canal. The area is designed to act as an emergency diversion point in the upper canal system, should conditions in the lower system warrant the need to quickly divert water to reduce flows in the lower system.

Routine use of the spill area as an artificial recharge site may not be acceptable to water users and people living in the vicinity of the spill area. Users are concerned that filling the spill area for recharge limits its usefulness in an emergency. Further, any water diverted into the spill area is no longer available for return into the canal system. Consequently, the user cannot reclaim the diverted water for downstream use once diversion occurs. Furthermore, local residents are concerned that continual use will affect drinking water quality in their domestic wells. They also fear that surface flooding could occur (none has ever occurred) and worry that basements may be flooded by sub-surface flows. These issues will have to be resolved before regular and protracted artificial recharge in the Hilton Spill area is implemented.

III. Assessment of the Potential for Artificial Recharge

There are two separate periods of potential for artificial recharge considered for this study -- the irrigation season, typically May through October, and the non-irrigation, or "off" season from November through April. Each season creates both similar and significantly different opportunities for artificial recharge.

During the irrigation season, the canal company's top priority is delivery of water to the user. Consequently, artificial recharge potential is subordinate to user demand during irrigation season and would likely be minimized; especially during periods of high irrigation demand.

Significant improvement in artificial recharge potential occurs during the off season. Several months (November and December; February and March) exist in which no water is typically diverted into the system. In addition, October and April typically are periods when only a fraction of the days in the month are used for diversion to users. Mr. Yost believes that recharge during mid-winter (January and February) is not feasible.

The Hilton Spill area, discussed above, is certainly one location that should be considered for artificial recharge. Although there are potential limitations in its use, these limitations are not insurmountable.

Mr. Yost also identified another potential location that could be inexpensively developed for recharge in either season. The entire area in the canal system "loop" from approximately 2 miles north of Pingree to the Hilton Spill Area west of Pingree (T3S, R33E, Sections 28, 32 and 33) is notorious for high losses or seepage. About mid-way down this loop (in Section 32) there is an old unused canal that was constructed in the early 1900's. Construction was abandoned when the workers encountered large sections of basalt in the area where the canal bed was being developed. (Basalt underlayment was avoided, if possible, because of basalt's known tendency to cause significant seepage or loss from the overlying canal due to the fractured and highly porous nature of the basalt surfaces.) Channel construction was diverted around the opposite side of a small butte and ultimately was opened as the canal that presently exists in the area.

Currently, the old channel is open but silted from years of inactivity. The structure is roughly 1300 feet long by 40 feet wide and 5 - 10 feet deep. It is physically located immediately adjacent to the existing canal system. Only the banks of the existing system separate the two channels. Mr. Yost believes that with a relatively minor investment the old channel could be opened and refurbished as an artificial recharge site. Mr. Yost feels the old canal could divert up to 1250 cfs; however, recharge capacity is uncertain. One would expect relatively high recharge rates, given the underlying basalt structure in the area and nearby losses in the active channel.

Mr. Yost believes that this old canal site could be used most effectively during the months of April, May and June; with minimum recharge during the high irrigation months of July and August. It is possible that the site may also be capable of significant recharge in September, October, November and March, with additional potential in February during relatively mild years. Several potential problems or limitations in use of this site for recharge exist. These limitations are discussed in context of the entire canal system in a separate section of this report, below. Potential recharge from this site is not included in the amounts shown in Figure E-1. Cost and acceptance of this addition to the system are too uncertain at this time.

"Normal" losses from the existing canal system (up to 65% of the amount diverted at the head-end of the system) could also be used during the "off" season as another source of additional recharge. Estimates of daily recharge rates from using the system in this capacity vary from an average of 800 cfs in the milder months to approximately one-half that amount (400 cfs) in the colder months. These limits are imposed primarily by the need to have the system available (dry) for preventive maintenance approximately half-time in milder months and one-quarter time in colder months of the off season. The manager's estimates of this potential recharge source throughout the year are reflected in amounts shown as "Recharge Capability" in Figure E-1.

Much of the area north of the Aberdeen-Springfield canal system is characterized as "waste ground"; which appears to have potential for artificial recharge development. However, one significant impediment may be issues of ownership and liability. According to area maps (BLM Blackfoot Quad, 1:100,000, topographic, 1978), much of the area in question is privately owned. Thus, arrangements for artificial recharge system construction and utilization would have to be closely coordinated with local landowners.

There may be some depressions in the lava beds northwest of Blackfoot, west of Springfield and northwest of the High Line Canal west of Grandview, Idaho, that border the canal or are in reasonable proximity and are on BLM ground (BLM map, 1978, cited above). If acceptable sites in these areas could be identified, the sites could have moderate potential for development as a cooperative effort between government agencies.

IV. Description of Problems Implementing Artificial Recharge

Several problems could significantly inhibit or completely prevent implementation of an effective artificial recharge capability in the Aberdeen-Springfield canal system. Each will be discussed below.

According to Mr. Yost, "Mother Nature" is the largest single deterrent to effective implementation of a consistent and effective artificial recharge strategy for the system. "Old-timers" have developed the current system through many years of experience. Significant changes in the current system would have to carefully allow for the capricious and often unforgiving nature of the elements with which we are working. For example, in good water years the canal system is often plugged with snow, particularly in the north-south reaches, well into March or early April. In dry years, the system may open earlier, but the opportunities for recharge may be limited by available water supplies.

Another example is the ability of the Aberdeen-Springfield system to "winter-over", as proposed for some systems further up the valley (e.g., canals in the Egin Bench area, west of St. Anthony, Idaho). The idea is to fill the system in early winter, let the surface of the canal freeze, and then recharge with flows in the open canal beneath the frozen surface. However, in the Aberdeen-Springfield system historical experience indicates the canals freeze from the bottom up; which nullifies the capability of feeding beneath the frozen canal surface.

Canal system maintenance is very important. Each year water is turned out on October 15. Maintenance begins immediately. The system must be kept intact and at peak readiness to serve the patrons. This is the primary responsibility of the canal system management -- effective and efficient service for the water user. Careful coordination of maintenance and recharge availability would be necessary for implementation of an effective artificial recharge program. One must understand that it typically takes 3 - 4 days to deliver water to the users when water is diverted into a dry canal system.

The Bureau of Reclamation currently restricts diversion for 5 months of the year (November - March). The Bureau may have to ease this restriction or otherwise reconsider in order for any significant off-season artificial recharge to take place.

Winter operation would be very difficult to manage. Early onset of protracted and extremely cold weather may damage canal components that are not properly winterized. In addition, thick ice formation could result in ice jams and subsequent localized flooding when winter Chinook or spring thaw takes place.

Burrowing animals (i.e., "gophers") are always a problem in the system. Their activity seems to be directly proportional to the amount of water in the system and the length of time the water is in the system. Additional flow for artificial recharge purposes may exacerbate this problem.

Finally, perceptions of individuals in the immediate area of recharge sites may need to be addressed as part of an artificial recharge strategy. As mentioned above, some people harbor fears and concerns about impacts of recharge on water quality, surface flooding, sub-surface flooding, and normal canal system operations. Some form of public awareness, demonstration, education and participation process may be necessary to prevent or mitigate intervention by those who are unconvinced that artificial recharge is beneficial.

V. Conclusions

Additional recharge is possible in the Aberdeen-Springfield canal system. In 1995, the company participated in the state's initial attempt to increase recharge in the eastern Snake River Plain. The company received credit for nearly 8,000 AF of artificial recharge in that time. Best opportunities for large volumes of artificial recharge occur in the fall and early spring when canal patron demand for water is lowest. The company may be able to divert up to 1100 cfs for artificial recharge during this period. However, to sustain this flow specifically for recharge (i.e., not in conjunction with irrigation demand) will require changes in the current system design. These changes are unlikely to occur without further incentives from the state to do so. Furthermore, not all patrons and residents in proximity of the canal system are convinced artificial recharge is beneficial.

APPENDIX F

American Falls Reservoir District #2

This report is a result of discussions between Big Wood and American Falls Reservoir District #2 Canal Company Manager Richard Oneida; North Side Canal Company Manager Ted Diehl; and Charles Brockway, Gary Johnson, and Jason Casper of the University of Idaho. A discussion of recharge potential from the Big Wood River Canal Company is included as a separate report. The discussions were held on March 27, 1996, in the office of North Side Canal Company.

I. System Operation

I.A Water Rights

The company holds water rights from the Snake River with a diversion point at Milner Reservoir. The district holds two water rights totaling 2550 cfs. Both rights have a 1921 priority.

I.B Average Irrigation Diversions

The largest daily diversion rate recorded in the 1980 to 1994 period was 1659 cfs (Water District 1 Annual Reports). Average monthly diversion rates were determined from Water District 1 Annual Reports (1980 to 1994) for Reservoir District #2. The average monthly diversion rates are presented in Table F-1 and shown in Figure F-1.

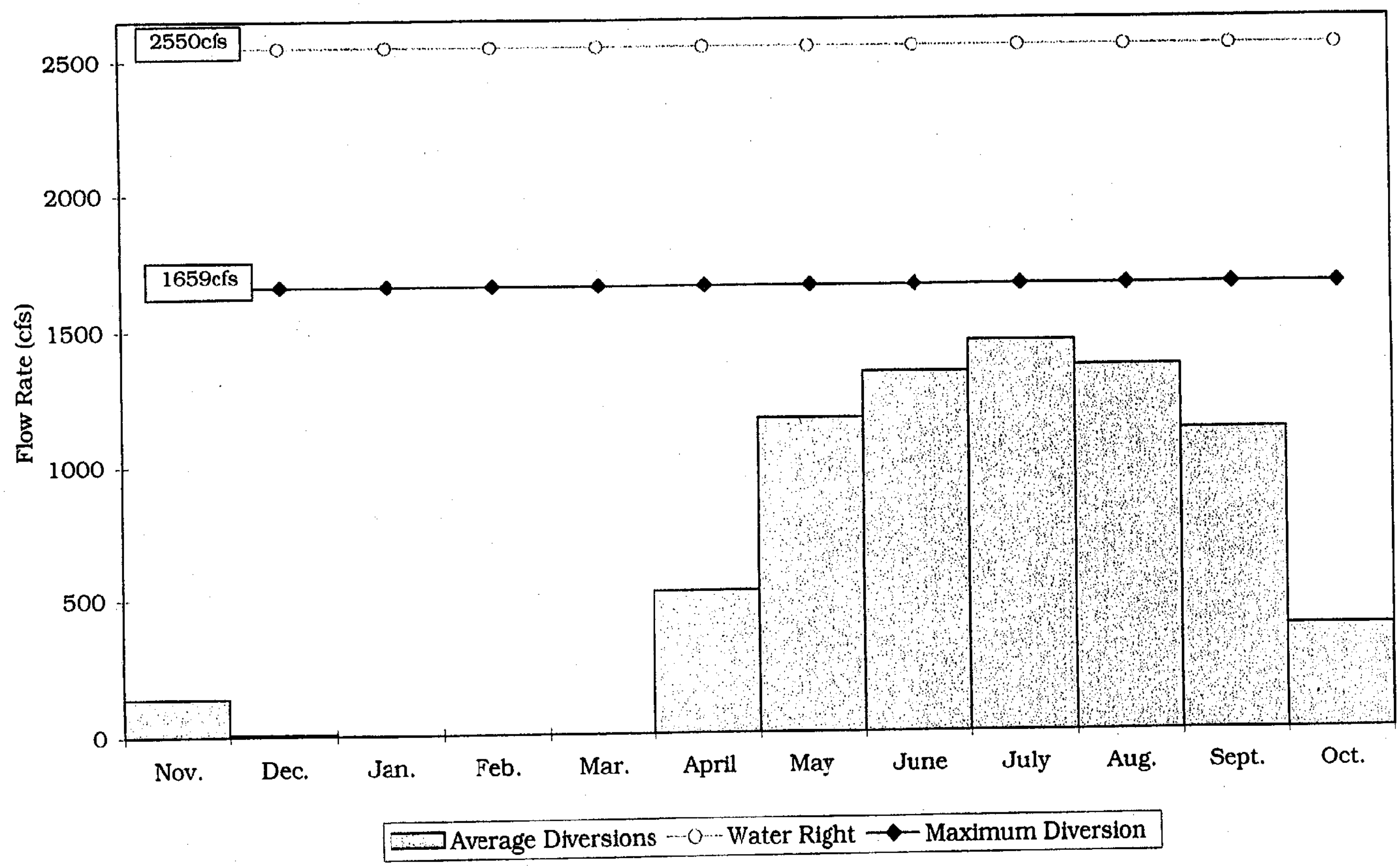

Figure F-1. Average Diversions of American Falls Reservoir Dist. #2.

Table F-1. Average Monthly Diversion Rates (1980-1994)

Month	Average Diversion (cfs)
November	140
December	6
January	0
February	0
March	0
April	521
May	1,168
June	1,335
July	1,448
August	1,356
September	1,118
October	378

I.C Physical Description of the System

American Falls Reservoir District #2 was formed in the 1920's to bring an additional 20,000 acres of land into production and to relieve some of the demand for water from the Big Wood and Little Wood rivers. The system currently serves about 64,000 acres of land. The district irrigates land on the north side of the Snake River, between Milner Dam and King Hill. Water is diverted from the Snake River at Milner Reservoir (T10S, R21E, S28) through the 73 mile length of the Milner-Gooding Canal. Less than one mile east of the City of Shoshone, water from the Milner Gooding Canal co-mingles with water from Little Wood River. During most of the irrigation season, about 40 percent of the flow of the Milner-Gooding Canal is routed down the Little Wood River channel to irrigate lands to the south and west. The remaining 60 percent of the flow continues in the Milner-Gooding canal to irrigate lands to the north and west, until the canal terminates near Thorn Creek. In the months of March and April, a larger percentage, perhaps 80 percent, is retained in the Milner-Gooding Canal past the confluence with Little Wood River.

About one mile northeast of Shoshone, the Milner Gooding Canal is concrete lined for a length of about 4 miles. The concrete lined section includes a flume that bridges the Big Wood River about 4 miles north of Shoshone. Gates on the flume allow Milner-Gooding canal water to be spilled into the Big Wood River channel if desired.

The Milner-Gooding Canal is linked to the Twin Falls North Side Canal through the A-Lateral and the Bypass Canal about 3 miles downstream of Milner Dam. Water is transferred from the Milner-Gooding Canal to the North Side Canal via these links. Diversion measurements for the Milner-Gooding Canal, however, are made after diversions into the A-lateral and Bypass canals, and consequently reflect actual diversions to Reservoir District #2.

The Milner-Gooding canal currently serves about 64,000 acres to the south and west of the canal (Figure F-2), and water from Big Wood and Little Wood Rivers is primarily used to irrigate lands north and east of the main canal.

<u>I.D Maximum Capacity</u>

The maximum capacity at head of the main canal, after diversion of North Side water in the A-lateral and Bypass canals, is estimated to be 1659 cfs (Figure F-1). This estimate was determined as

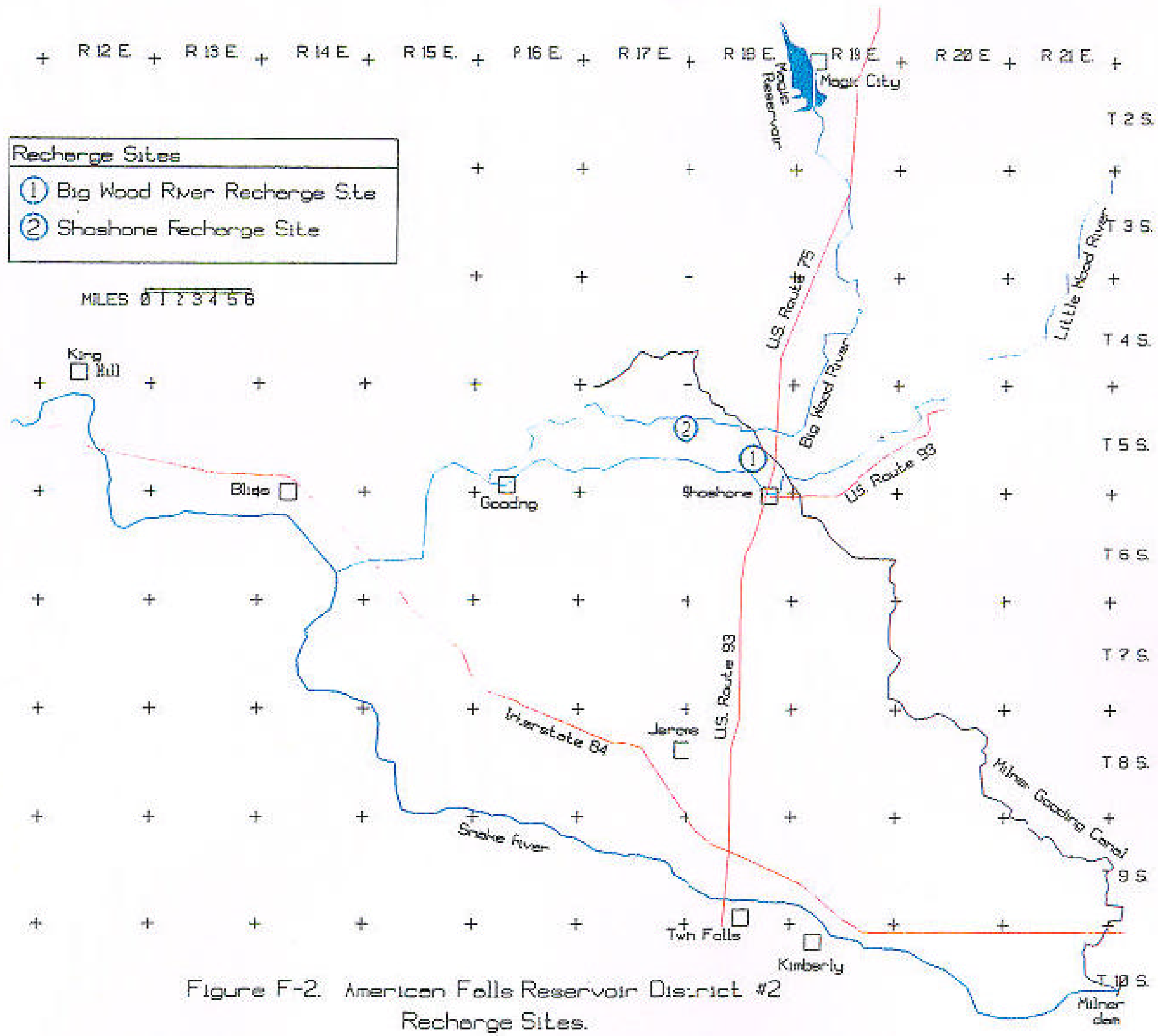

Figure F-2. American Falls Reservoir District #2 Recharge Sites.

the highest daily diversion during the 1980 through 1994 period. The capacity of the canal below the confluence with the Little Wood River is about 650 cfs and decreases in capacity progressively downstream.

II. Artificial Recharge Experience

American Falls Reservoir District #2 first became involved in intentional recharge activities in 1987 when the Lower Snake River Aquifer Recharge (LSRAR) District was formed. The Milner-Gooding Canal is used by the LSRAR District to deliver water to a natural depression in the lava flows about 3 miles northwest of Shoshone. This recharge site was used in 1994 and 1995 with storage water purchased by the recharge district and by the State of Idaho. In 1995, the Milner-Gooding canal was used to deliver about 48,000 acre-feet of Snake River water from Milner Reservoir to the recharge site. Water was also diverted from the Little Wood River to the recharge site (Carlson, 1996). All artificial recharge was terminated by July 4, 1995.

The artificial recharge experience at the LSRAR District site has shown that the current maximum rate of recharge is about 450 cfs. Larger flows, without modification to the existing basins, may result in structure damage. Higher flow rates, possibly as high as 600 cfs, could be achieved by raising dike elevations and/or enlargement of constrictions within the basin. The maximum flow rate of 450 cfs into the site resulted in a pond of about 6 acres. It is not known if pond size was stable with the 450 cfs of inflow, or if the extent of the impoundment was continually growing. The pond dried up within hours after inflow was ceased, indicating that infiltration rates were large and that the extent of the ponds would not grow much beyond that experienced in 1995 at continuous flow rates of 450 cfs.

The LSRAR District monitors water quality and ground-water levels in response to artificial recharge activities. The District samples ground water from two nearby wells. Water levels are measured in six surrounding wells (D. McFaddan, oral communication). The 1995 experience demonstrated that some local residents are concerned about possible adverse impacts associated with artificial recharge, and that monitoring is needed to diffuse potential public relations problems.

In 1996, water from the Milner-Gooding canal was again discharged to the recharge site at a flow rate of 450 cfs beginning on March 26. At the time of this report, artificial recharge was ongoing and no total recharge values were available.

III. Assessment of the Potential for Artificial Recharge

Artificial recharge appears possible at two sites in the Reservoir District # 2 system:

1. The LSRAR District site, 3 miles northwest of Shoshone,
2. The Big Wood River channel below the confluence with the Milner-Gooding canal.

III.A The LSRAR District Site (T5S,R17E,S22)

The LSRAR District site is in a natural depression in the lava flows about 3 miles northwest of Shoshone. The site is currently capable of infiltrating about 450 cfs, probably for an indefinite period. The capacity can be increased with minor structural modifications, perhaps to as much as the local carrying capacity of the Milner-Gooding Canal of 650 cfs. The site is relatively remote, and it is unlikely that recharge at rates of less than 650 cfs will result in adverse impacts due to elevated ground-water levels.

Water may be diverted to the site from either the Little Wood River or the Snake River via the Milner-Gooding Canal. During the irrigation season, recharge potential is limited to the canal capacity that is not needed for irrigation supply. For the Milner-Gooding Canal the limitation occurs in the canal north of the intersection with Little Wood River. The canal capacity in the section between Little Wood River and the Snake River Recharge District site is about 650 cfs. During the months of peak irrigation demand, the entire canal capacity is needed to deliver irrigation water, eliminating the possibility for artificial recharge. The estimated monthly diversions through this section of the canal, and the remaining capacity available for recharge are listed in Table F-2 and shown graphically in

Figure F-3. In the early spring months water is often available from the Big or Little Wood Rivers to supplement irrigation needs and relieve some of the demand for water from the Milner-Gooding canal.

Table F-2. Estimated Milner-Gooding flows in the section between Little Wood River and LSRAR District site and remaining canal capacity

Month	Irrigation Flows (cfs)	Remaining Capacity (cfs)
Nov	50	600
Dec	0	0*
Jan	0	0*
Feb	0	0*
Mar	0	325*
Apr	250	400
May	300	350
Jun	650	0
Jul	650	0
Aug	650	0
Sep	450	200
Oct	100	550

* Constrained by winter conditions.

During the non-irrigation season, from November through March, recharge potential is limited by freezing and adverse weather and accessibility. The extreme length of the Milner-Gooding canal, through rugged terrain, makes winter accessibility a problem. Freezing conditions, resulting in possible structure damage and possibly flooding make operation impractical from about December 1 through March 15.

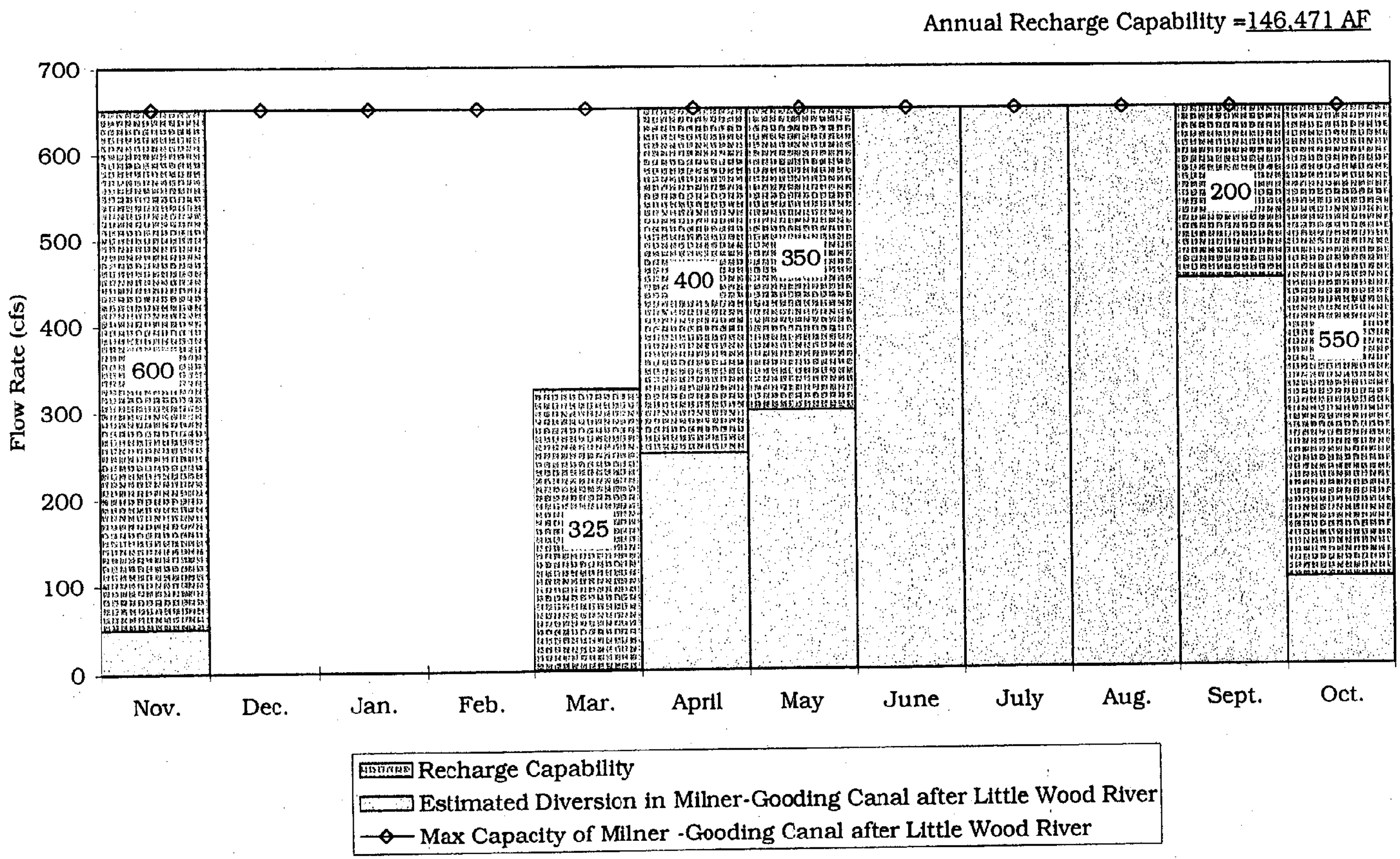

Figure F-3. Estimated Recharge Capability of American Falls Reservoir District #2.

III.B Big Wood River Channel Below the Milner-Gooding Canal

Water from the Snake River or Little Wood River may be delivered via the Milner-Gooding canal to Big Wood River as means of increasing recharge when Big Wood River is dry below the Milner-Gooding flume, north of Shoshone. Most of the losses from the Big Wood River channel are expected to occur upstream of the Milner-Gooding flume, so the recharge potential from this activity appears limited, and unquantified. The Big Wood River is normally dry in this segment from October through mid-April.

Artificial recharge in the Big Wood River channel is also constrained by winter conditions, preventing operation of the Milner-Gooding Canal. From the first of December through mid-March winter conditions prohibit use of the Milner-Gooding Canal. The artificial recharge opportunity is therefore limited to mid-March to mid-April, and October through November. No capacity for artificial recharge is estimated for the Big Wood River channel since the opportunities and rates appear limited.

IV. Description of Problems Implementing Artificial Recharge

Operation of the canal system during the months of December, January, February, and the first half of March is impractical. Possible ice damage and inaccessibility of the canal system due to snow-closed roads prohibit operation of the system. The system is not constrained to irrigation season operation with a U.S. Bureau of Reclamation contract because Reservoir District #2 has no contract for storage in Palisades Reservoir.

Ability to intentionally recharge through the LSRAR District site is proven. Adverse impacts resulting from elevated ground-water levels or water quality degradation are unlikely. Past experience, however, has shown that it is necessary to monitor water levels, and water quality in order to provide the necessary assurance to local residents that adverse effects are not occurring. Expanding the capacity of the site may require additional road and dike construction.

Diversion of Snake River water into the channel of the Big Wood River below the confluence with Milner-Gooding Canal represents a limited capacity for recharge which was not included in recharge totals for this district.

V. Conclusions

Reservoir District #2 can deliver up to 600 cfs to the LSRAR District site. This rate of recharge would require some additional construction. During the irrigation season there is little capacity in the Milner-Gooding canal north of the confluence with Little Wood River above the capacity required to deliver irrigation water. The total annual recharge potential appears to be about 146,000 acre-feet.

Adverse impacts associated with artificial recharge at any of the sites are expected to be minimal.

APPENDIX G

North Side Canal Company

This report is a result of March 27, 1996, discussions between North Side Canal Company Manager Ted Diehl; Big Wood and Reservoir District #2 Canal Company Manager Richard Oneida; and Charles Brockway, Gary Johnson, and Jason Casper of the University of Idaho.

I. System Operation

I.A Water Rights

The company holds water rights from the Snake River with a diversion point at Milner Reservoir. Five water rights are held by the company:

Priority	cfs
1900	400
1905	2250
1908	350
1915	300
1920	1260
Total	4560

The total water right is displayed in the graph of average monthly diversion rates for the North Side Canal Company (Figure G-1). The water right includes water diverted from Milner Reservoir through the North Side Canal, and the Milner-Gooding Canal through the A-lateral and the North Side Diversion from Milner-Gooding (crosscut canal), and the PA-lateral which does not enter the main canal system.

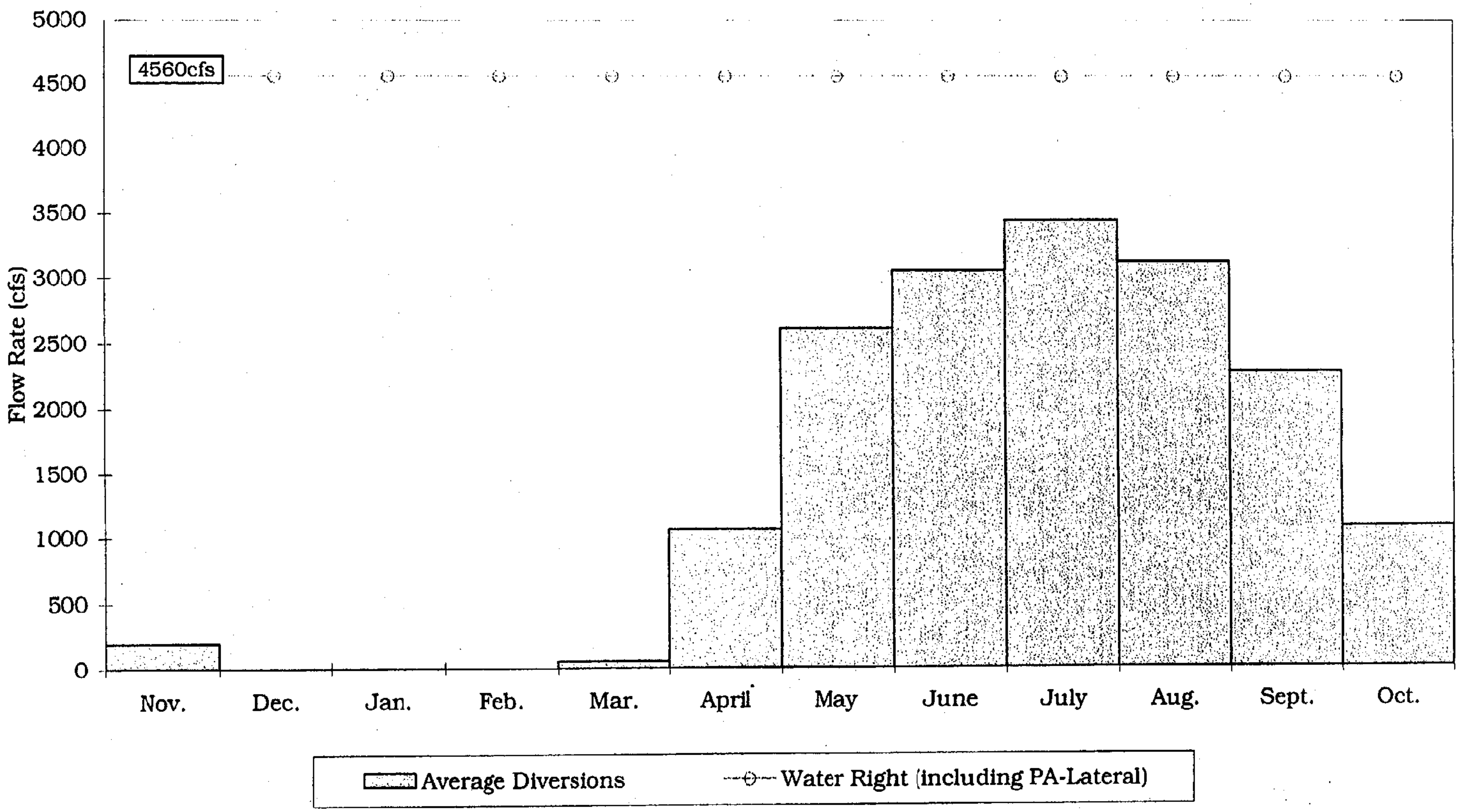

Figure G-1. Average Diversions of North Side Canal Company.

Storage is owned in Jackson Lake, Palisades, and American Falls reservoirs. The total storage space owned is 851,679 acre-feet.

I.B Average Irrigation Diversions

The average monthly diversion rates, determined from Water District No. 1 Annual Reports are presented in Table G-1. These values (also presented in Figure G-1) represent monthly average diversion rates for the 1980 through 1994 period. The PA lateral is not included in the values given in the table or in the figure because the lateral is isolated from the rest of the system and is not relevant to artificial recharge discussions. Diversions shown in Figure G-1 cannot be directly compared to the water right because the water right also includes the North Side PA-lateral that was not included in the graph.

Table G-1. Average Monthly Diversion Rates (1980-1994)

Month	Diversion Rate (cfs)
November	196
December	0
January	0
February	0
March	52
April	1,056
May	2,614
June	3,055
July	3,444
August	3,120
September	2,280
October	1,077

I.C Physical Description of the System

The North Side Canal Company diverts water from the Snake River at Milner Reservoir (T10S,R21E,Sec29) to irrigate 160,000 acres. Diversions from the reservoir are made through the North Side main canal, the Milner-Gooding canal, and the PA-lateral. Diversions into the Milner Gooding canal are transferred to the North Side main canal via the A-lateral and the Crosscut or bypass canal. Diversions in the PA-lateral do not combine with the rest of the flows in the North Side system.

Four hydropower plants exist on exist on the main canal and on the Crosscut. The main canal subsequently flows through Wilson Lake and into a network of laterals that ultimately extends several miles west of Bliss (Figure G-2). Return flows from the system return to the Snake River as either surface or ground water. Recent efforts have been made to infiltrate all return flows to enhance water quality of the Snake River and provide wildlife habitat. Ponds currently exist at the end of several laterals, near the rim of the Snake River canyon. North Side Canal Company has partial ownership of the Milner Hydro Plant and receives royalties from the four power plants on the main canal. Sprinkler irrigation is becoming more popular with North Side irrigators. Approximately 70 percent of lands irrigated with North Side water are sprinkler irrigated.

I.D Maximum Capacity

The maximum capacity of the main canal, after the confluence with the A-lateral and the Crosscut is at least 3500 cfs. This estimate was determined as the sum of average July diversions in the North Side Main, Crosscut, and A-lateral. The capacity of the canal decreases progressively along the length as additional laterals divert flow from the main canal. The capacity of the head of the main canal does not appear to be a constraint for artificial recharge.

II. Artificial Recharge Experience

North Side Canal Company participated in two recharge programs in 1995. The first program recharged water rented from the City of Pocatello by the Snake River Recharge District. This effort lasted until April 7. The second program began in mid-April and lasted until late June (North Side Canal Company 1995 Annual Report). The second effort recharged water rented from the rental pool by the Idaho Department of Water Resources and natural flow. The Department credited North Side with over 14,000 acre-feet of recharge to 11 sites. These sites included "waste" ponds designed to infiltrate return flows and other locations that could be easily flooded without adverse impacts.

The North Side Canal Company was also involved in recharge efforts in 1993 and in 1994.

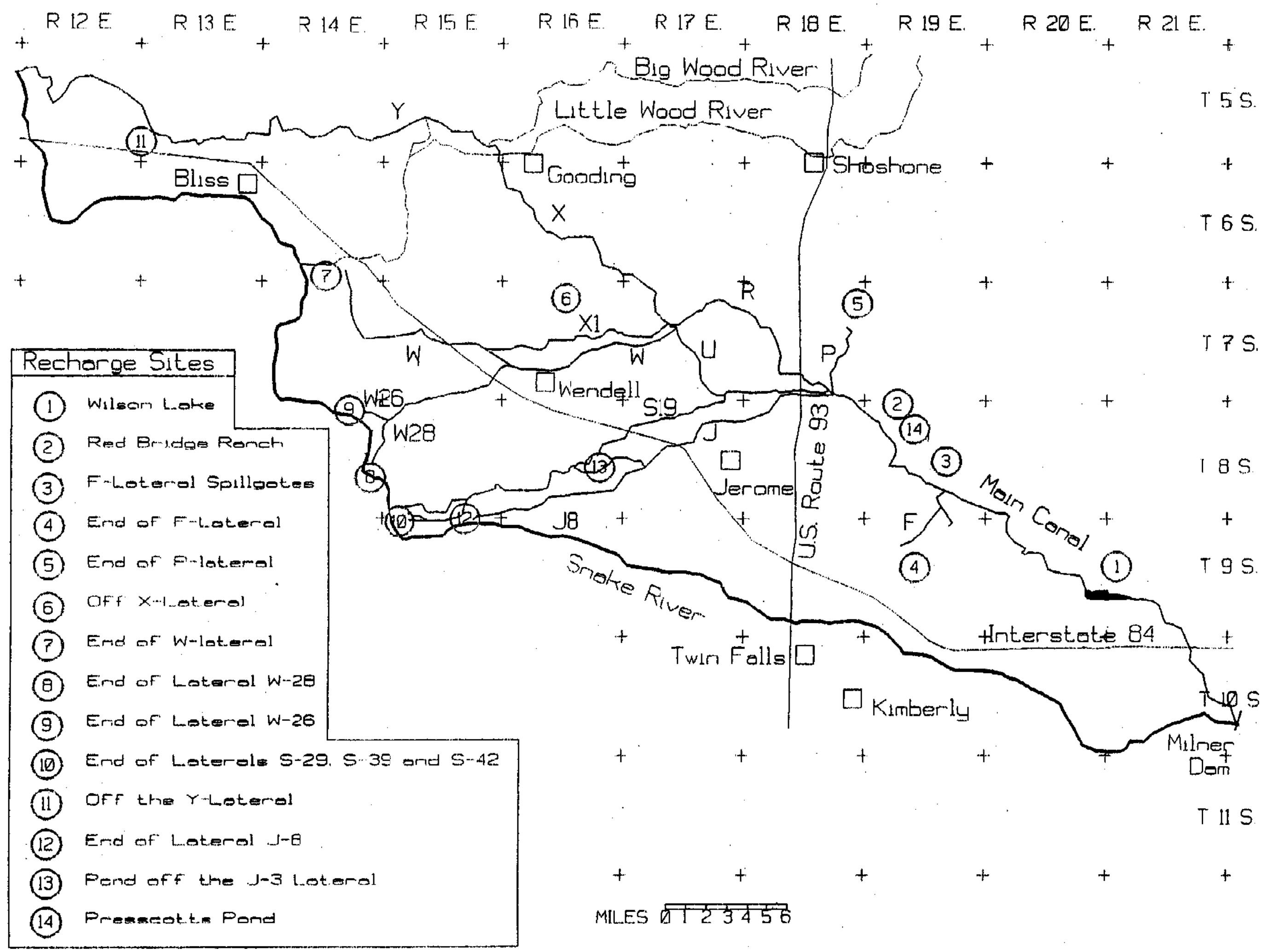

Figure G-2. The North Side Canal System.

III. Assessment of the Potential for Artificial Recharge

Artificial recharge in small amounts is possible at multiple sites within the North Side system. Rates of artificial recharge at these sites are probably constrained by infiltration rates at the individual sites and the capacity of the local lateral to deliver the water. The identified potential sites are as follows:

1) Wilson Lake on the main canal (T9S,R20E,Secs19,27,28,29,30,35)
2) Red Bridge Ranch off the main canal (T8S,R18E,Sec8)*
3) At the F-lateral spill gates (T8S,R18E,Sec26)*
4) End of the F-lateral (T9S,R18E,Sec 10)*
5) End of the P-lateral (T7S,R18E,Sec18)*
6) Off the X-lateral (north half of T8S,R15E)
7) End of the W-lateral (T6,R13E,Sec35)
8) End of lateral W-28 (T8S,R14E,Sec20)*
9) End of lateral W-26 (T8S,R14E,Sec6)*
10) End of laterals S-29, S-39, and S-42 (T8S,14E,Sec34)
11) Off the Y-lateral (T5S,R12E,Sec29)
12) End of lateral J-8 (T9S,R15E,Sec6)
13) Pond off the J-3 lateral (T8S,R15E,Sec24)
14) Prescott's Pond (T8S,R18E,Sec9)*

* identified as receiving recharge in 1995 (R. Carlson, 1995)

Many of these sites are currently in use for infiltration of return flows and were used in 1995 for artificial recharge. Some require construction of ponds or structures. In many cases, infiltration ponds would be able to serve the dual purpose of artificial recharge and of infiltrating returns flows for improved water quality. In addition, several sites exist that have been used to recharge at rates of 2 cfs or less. These sites do not represent a significant potential recharge source, and generally require an unacceptably high level of operational attention for small amounts of recharge.

Use of the sites listed above is constrained by use of the canal system for irrigation and by winter weather. Capability of each site for artificial recharge is as follows:

Wilson Lake

The main canal flows through Wilson Lake. Seepage out of the lake is normally controlled by maintaining the water level below a certain elevation. When water levels are raised above the "leaky" elevation, seepage of up to 100 cfs is expected. Running water in the main canal and keeping Wilson Lake full during the irrigation season will result in about 100 cfs of artificial recharge from March 1 through November 30.

Red Bridge Ranch

Red Bridge Ranch is located on private ground off the main canal. It has an estimated maximum recharge capacity of 50 cfs. This site recharged a total of 4260 acre-feet in 1995, at a maximum flow rate of 35 cfs (computed from daily flow rates). The site can be used in the March 15 to December 1 period when capacity exists beyond that needed for delivery of irrigation water. It is estimated that 50 cfs can be delivered from March 15 to June 30, and from September 1 through November 30. During July and August the full canal capacity is normally needed for irrigation deliveries.

The F-lateral spill gates

With additional dike construction, the F-lateral spill gate area may be able to recharge 10 cfs in the March 15 to June 30 and from September 1 through November 30 periods. During peak irrigation season, in July and August, recharge capacity is probably limited to about 2 cfs.

End of the F-lateral

A recharge site off the F-lateral, on the southwest side of the railroad tracks, can provide up to 10 cfs of recharge during the March 15 to June 30 period and during the months of September, October and November. During July and August, a lesser rate of perhaps 2 cfs should be attainable.

End of the P-lateral

An injection well at the end of the P-lateral could provide for up to 2 cfs of recharge during the period of March 15 through June 30 and from September through November.

Off the X-lateral

Good opportunities for artificial recharge exist in the BLM ground off the X-lateral in the area northeast of Wendell. This area could potentially recharge up to 100 cfs from March 15 through April 30 and in September, October, and November. In May, June, July, and the first half of August the capability to deliver water to this site is probably limited to 20 cfs. In the last half of August, the potential for delivery probably increases to 50 cfs. Cooperation of the BLM would be necessary to utilize this recharge area.

End of the W-lateral

An existing waste pond at the end of the W-lateral has been used for recharge in 1994 and 1995. The pond is within a mile of the Snake River Canyon, and consequently provides relatively immediate and localized effects of supplementing spring flows. Water quality may also be a concern in recharging so near to the point of aquifer discharge. The pond is capable of providing about 5 cfs of supplemental recharge (in addition to that resulting from normal irrigation practices) from March 15 through June, and from September through November.

End of the W-28 lateral

Two existing ponds at the end of the W-28 lateral are currently used for infiltrating waste water and as a wetland managed by the Nature Conservancy. The two ponds have a capacity to infiltrate an additional about 10 cfs during from March 15 through June, and from September through November. Again, because of the proximity of this site to the Snake River canyon, recharge effects will be immediate and localized.

End of the W-26 lateral

New ponds can be constructed at the end of the W-26 lateral to infiltrate additional water. This site could provide an additional 10 cfs of aquifer recharge from March 15 through November. The recharge water would be from normal irrigation returns and from supplemental diversions for recharge.

End of laterals S-29, S-39, and S-42

Approximately 5 cfs can be recharged from March 15 through April 30 and in the months of September, October, and November at existing sites at the ends of the laterals. These sites are near the canyon rim and supplemental recharge is likely to have immediate impacts.

Off the Y-lateral

This recharge site is near the western boundary of the North Side service area, about 5 miles west of Bliss. Because of the extreme western location of this site, recharge benefits may be most apparent in springs downstream of Malad Gorge. This site may be able to recharge 50 cfs during the March 15 through April 30 period and the September through November period.

End of the J-8 lateral

Two existing ponds at this site are capable of recharging 5 cfs. The ponds are currently used during the irrigation season, consequently their use for supplemental recharge would be from March 15 through April 30 and from September 1 through November 30. The proximity of this site to the canyon will also result in immediate effects at nearby springs.

Pond off the J-3 lateral

A pond off the J-3 lateral has been used for artificial recharge in 1995 and 1996. This 6 to 7 acre pond is on BLM property and located about 6 miles west, and 3/4 mile south of Jerome. The pond is capable of infiltrating about 5 cfs. The operation of this recharge site is probably limited to March 15 through April 30 and from September 1 through November 30.

Prescott's Pond

An existing pond off the main canal , after the L-lateral, has been used for artificial recharge in the past and represents an opportunity for about 5 cfs of artificial recharge in the future. This site can be used from March 15 through June 30, and from September 1 through November 30. During July and August the full canal capacity is needed for irrigation.

Summary of Potential Recharge Sites

Fourteen potential recharge sites are described above. The potential recharge from these sites is summarized in Table G-2. The potential recharge (third column of Table G-2) is less than the equivalent maximum flow rate (second column of Table G-2) over the period of a year. This is because the maximum flow rate occurs for only a period of a few months. The values presented in the third column represent the sum of the monthly recharge rates (converted to acre-feet) for each site, as presented in the descriptions of the individual sites in the preceding section.

IV. Description of Problems Implementing Artificial Recharge

Operation of the canal system during the months of December, January, February, and the first half of March is impractical. Possible ice damage and inaccessibility of the canal system due to snow-closed roads prohibit operation of the system. The system is also constrained to irrigation season operation with a U.S. Bureau of Reclamation contract.

Recharge near the canyon rim has relatively immediate impacts on nearby springs, but will be of limited value for more distant springs. The benefits of recharge from the areas may also disappear soon after recharge ceases. Recharge water quality may be of greater concern from recharge areas near springs. Shorter aquifer flow paths and retention times reduces the opportunities for filtration; chemical adsorption, reaction, and ion exchange; and die-off of microorganisms.

The distributed effects of artificial recharge from the multiple small sites within the North Side canal minimize the potential for excessive water table mounding. The relatively high population density of the area, however, may result in perceived adverse impacts.

V. Conclusions

North Side Canal Company has at least 14 existing or potential sites that can be used for artificial recharge. Most of these sites have relatively small potential, the largest being Wilson Lake and the BLM owned land off the X-lateral, each of which have the capacity to recharge about 100 cfs. The artificial recharge capacity of the North Side canal system is shown in Figure G-3 and listed in Table G-3. Recharge during summer months is limited due to use of the canals for irrigation. During winter months the recharge is not possible due to icing and weather conditions.

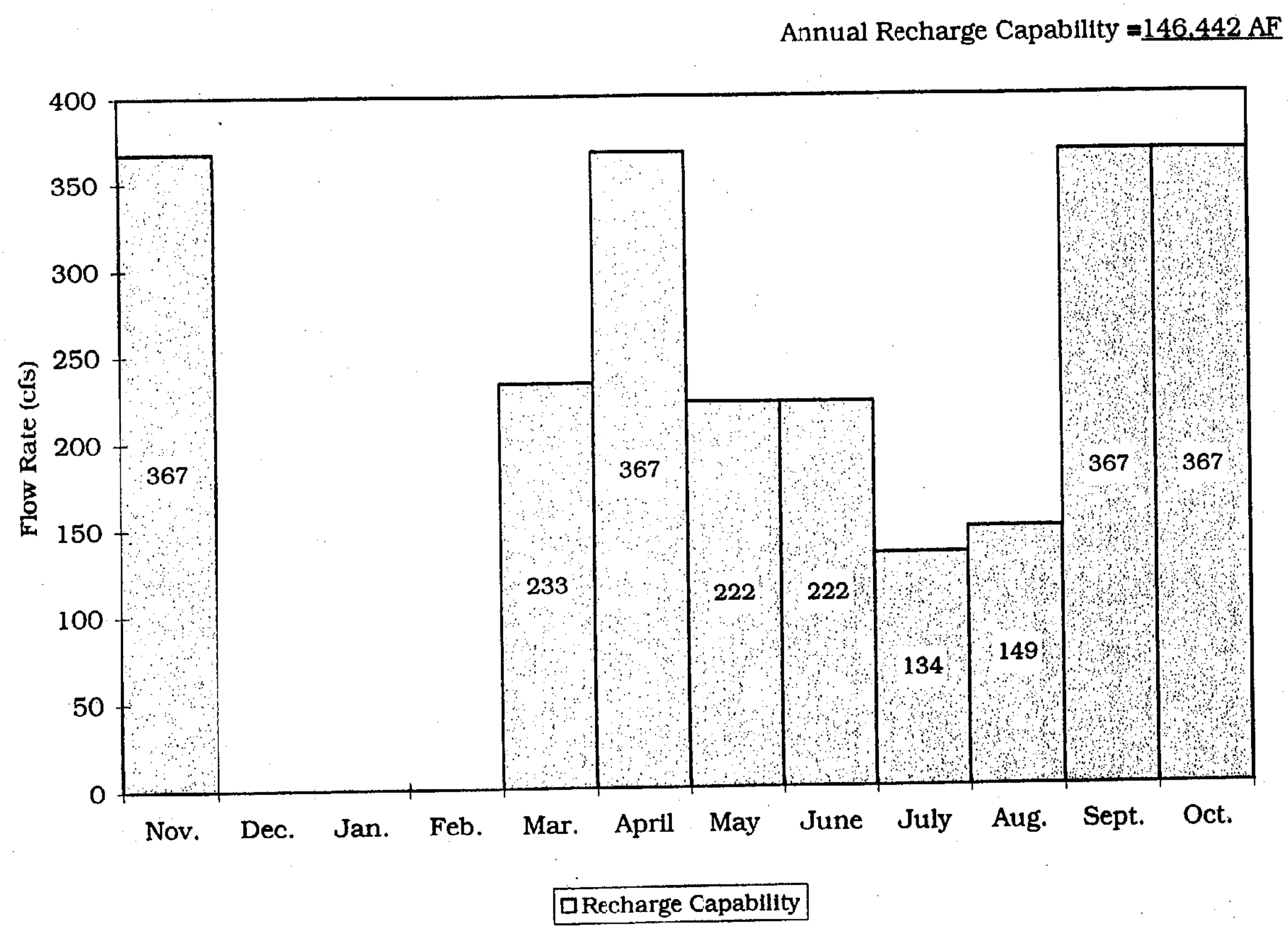

Figure G-3. Estimated Recharge Capability of North Side Canal Company.

Table G-3. Artificial Recharge Capacity of the North Side Canal Company System

	Recharge Potential	
Month	**(cfs)**	**(acre-feet)**
November	367	21,800
December	0	0
January	0	0
February	0	0
March	233	14,332
April	367	21,799
May	222	13,626
June	222	13,187
July	134	8,225
August	149	9,146
September	367	21,800
October	367	22,526
TOTAL	NA	146,442

Many of the recharge sites are near to the Snake River Canyon. Effects of recharge at these sites will be immediate, localized, and will dissipate soon after recharge ceases.

APPENDIX H

Big Wood Canal Company

This report is a result of discussions between Big Wood and Reservoir District #2 Canal Company Manager Richard Oneida; North Side Canal Company Manager Ted Diehl; and Charles Brockway, Gary Johnson, and Jason Casper of the University of Idaho. The discussions were held on March 27, 1996 in the office of Northside Canal Company. The report discusses the potential for artificial recharge of the Snake River Plain aquifer from the Big Wood River. American Falls Reservoir District #2 is managed from the same office as Big Wood Canal Company, however, the artificial recharge opportunities associated with Reservoir District #2 are discussed in a separate section of this document.

This section discusses operations of the canal company in less detail than other sections because the identified artificial recharge site is not dependent upon facilities of the canal company.

I. System Operation

I.A Water Rights

The Big Wood Canal Company holds water rights from Camas Creek, Big Wood River, and Little Wood River. The water rights from Camas Creek and Big Wood River are about 3,000 cfs each, and the water right from the Little Wood River is about 350 cfs. The water right priorities from Camas Creek and Big Wood River are in the late 1800's or early 1900's. Water rights from the Little Wood River carry a wide range of priority dates. The company owns Magic Dam and all storage within the reservoir.

I.B Average Irrigation Diversions

The Big Wood canal system is not expected to serve as a delivery channel for artificial recharge. Diversions and capacity of the Big Wood canal system are therefore not relevant to this evaluation and are not included in the report.

I.C Physical Description of the System

The Big Wood Canal Company has grown and changed since its conception in the early 1900's. The company constructed Magic Reservoir on the Big Wood River in 1910. Water from Camas Creek, Big Wood and Little Wood Rivers was inadequate to irrigate all the arable lands within the service area. Consequently in 1927, American Falls Reservoir District #2 was formed to irrigate part of the area and bring an additional 20,000 acres under production with water diverted from the Snake River through the Milner-Gooding Canal. Currently, the Big Wood Canal Company irrigates about 74,600 acres of Land from the Big and Little Wood Rivers and utilizing storage in Magic Reservoir. Magic Reservoir fills in a normal water year, spilling water down the channel of the Big Wood River.

I.D Maximum Capacity

The Big Wood canal system is not expected to deliver water to artificial recharge sites, and therefore canal capacity is not relevant and not discussed in this section.

II. Artificial Recharge Experience

The Milner-Gooding Canal (American Falls Reservoir District #2) has been used to deliver water from the Little Wood River to the Snake River Recharge District site north of Shoshone. In

1995, about 7,400 AF were diverted to the site from Little Wood River. Co-mingling of waters from the Little Wood River and the Milner-Gooding canal makes such diversions possible. This site is sufficiently remote that few, if any, adverse impacts are expected from artificial recharge. The site is primarily used for artificial recharge of water from the Snake River through the Milner-Gooding Canal. Additional information on artificial recharge at this site is provided in Appendix F, the discussion of American Falls Reservoir District #2 artificial recharge capabilities.

III. Assessment of the Potential for Artificial Recharge

The potential for increasing recharge from the Big Wood and Little Wood Rivers has been demonstrated at two sites:

1) The Snake River Recharge District pond, 3 miles north of Shoshone (T5S,R17E,Sec 22), and
2) The Cottonwood area in (T3S, R18E, Sec 27), off the Big Wood River.

The Snake River Recharge District Pond north of Shoshone can be recharged from Little Wood River through diversion into the Milner-Gooding canal. The potential for recharge is limited to periods when all senior water rights on the Little Wood have been satisfied. The Milner-Gooding Canal is also used for delivery of irrigation water and artificial recharge water from the Snake River. The canal has a capacity of 650 cfs between Little Wood River and the existing recharge site. The recharge site has a current capacity of about 450 cfs, but could be enlarged to about 600 cfs. The capacity of this recharge site, without regard to the source of water, is discussed in the report of American Falls Reservoir District #2.

The Cottonwood area (T3S,R18E,S27) is located on U.S. Bureau of Land Management property in lava beds adjacent to the Big Wood River about 10 miles below Magic Reservoir. The Cottonwood site is a natural depression that fills with water from the Big Wood River in periods when water is high enough to locally overflow the river bank. Because of the site's location, adjacent to the Big Wood River, canals are not needed to deliver water and canal company operations are relevant only to estimation of available water supply for artificial recharge, which is beyond the scope of this report. Only water from the Big Wood River and Camas Creek can be diverted into this site. The site has not been previously used for managed recharge, although high flows of the Big Wood River have previously overflowed the banks and spilled into this area. "Old-timers" claim that in the past water has flowed through this depression all the way down to the Little Wood River, about 10 miles to the south. The capacity of this area to infiltrate water is unknown. The site is remote, and therefore its use does not appear to represent significant local adverse impacts. The Bureau of Land Management would need to be contacted to determine availability of the site.

IV. Description of Problems Implementing Artificial Recharge

Artificial recharge at the Snake River Recharge District site north of Shoshone during the months of December, January, February, and the first half of March is impractical due to icing problems with the Milner-Gooding Canal. Possible ice damage and inaccessibility of the canal system due to snow-closed roads prohibit operation of the system. Use of this site must be coordinated with irrigation deliveries from the canal and use of the canal to deliver artificial recharge from the Snake River. The system is not constrained to irrigation season operation with a U.S. Bureau of Reclamation contract.

Ability to provide recharge through the Snake River Recharge District site is proven. Adverse impacts resulting from elevated ground-water levels or water quality degradation are unlikely. Past experience, however, has shown that it is necessary to monitor water levels, and water quality in order to provide the necessary assurance to local residents that adverse effects are not occurring. Expanding the capacity of the site may require additional road and dike construction.

Managed recharge via the Cottonwood site can occur directly from the Big Wood River and therefore does not affect canal company operations. The Cottonwood site is sufficiently remote that local changes in ground-water levels should not present a problem. Water quality, though always a consideration, should be no more of a concern than at any other recharge sites. Water availability for this site is limited to supplies in the Big Wood River below Magic Reservoir. Runoff in excess of the storage capacity of Magic Reservoir may be diverted into the Cottonwood site, however, the period in which water is available may be rather brief. Water diverted into the Cottonwood site will not flow down the remainder of the Big Wood River channel which may offend downstream interests, and deplete aquifer recharge that would have resulted from seepage in the lower reaches of the river. The extent of the pool of water forming at the Cottonwood site is unknown, and the Bureau of Land Management would have to be involved with any recharge activities at this site.

V. Conclusions

Artificial recharge from the Big Wood River can be achieved by diversion into the Cottonwood area below Magic Reservoir. This activity does not require use of any irrigation canals, but is limited by the amount of water available in the Big Wood River. Water diverted into this site may diminish natural recharge occurring in lower reaches of the river and may be opposed by water right holders downstream of the recharge area. No estimates of recharge potential are available for this site.

Artificial recharge can be diverted from the Little Wood River to the Snake River Recharge District site near Shoshone via the Milner-Gooding Canal. This recharge activity must be coordinated with operation of the Milner-Gooding Canal. The canal may be used for irrigation and for delivering artificial recharge water from the Snake River to the Snake River Recharge District site. An evaluation of the recharge potential for this site is provided in Appendix F, American Falls Reservoir District #2.

APPENDIX I

Lower Snake River Aquifer Recharge District

This report is generated from information received by letter from Mr. Dan McFadden (May 24, 1996), Chairman of the Lower Snake River Aquifer Recharge (LSRAR) District. The District has been involved in development of artificial recharge capabilities since the mid-1980's and is included in this report because of the significant efforts being made by the District to conduct artificial recharge.

I. System Operation

I.A Water Rights

The District holds water rights for 1200 cfs of natural flow from the Snake River above Milner Dam with a 1980 priority date. The District also holds rights for 800 cfs of natural flow from the Big and Little Wood Rivers. The right to Snake River water is exercised by diversion and conveyance through both the Milner-Gooding Canal, under purview of American Falls Reservoir District #2, and the North Side Canal, operated by the North Side Canal Company. Little Wood River water is diverted and conveyed exclusively through the Milner-Gooding Canal. These arrangements for diversion and conveyance have been accomplished through a permissive agreement with the U. S. Bureau of Reclamation.

I.B Average Irrigation Diversions

Irrigation diversions are relevant to activities of the District only in that Milner-Gooding and North Side canals must give priority to irrigation demands over recharge. The diversions in these systems are addressed in the specific appendices of this report for the respective systems (Appendix F for Milner-Gooding; Appendix G for North Side). Recharge sites and canals may be jointly used by the canal companies and the District.

I.C Physical Description of the System

The LSRAR District comprises a relatively small area in the southern portion of Gooding County. The District area is roughly shaped like the letter "L" (Figure I-1). From the southeastern most point of the county, at the Snake River, the District boundary follows the river downstream (i.e., to the west and north) to a point just southwest of Bliss. From this point the boundary extends north approximately one mile to State Highway 20/26. Here the boundary extends due east approximately nine miles to the intersection of Highway 20/26 and State Highway 46. At this point the boundary extends due south for approximately 17 miles to a point about one mile from the Snake River. Here the boundary extends due east for approximately nine miles and then follows the Gooding County line due south to the point of origin on the Snake River.

The LSRAR District was formed as a result of a grassroots movement initiated by irrigators and aquaculture interests in the Hagerman Valley who were concerned about declining spring flows in the area. These water users noted a direct correlation between area spring flows and irrigation flows in the canals above the valley. Consequently, the users decided to form the recharge district to augment the incidental recharge with artificial recharge, and thereby attempt to improve the spring flows.

During the 1970s, the group worked to develop and pass legislation to form the District and conduct artificial recharge operations. In the early 1980s, this legislation was finally passed and the District began bona fide artificial recharge operations.

Currently, the District includes approximately 135 patrons and is administered by a five-member elected board of directors who also appoint a treasurer and hire a secretary. Since the District was formed, it has spent over $150,000 to construct and improve

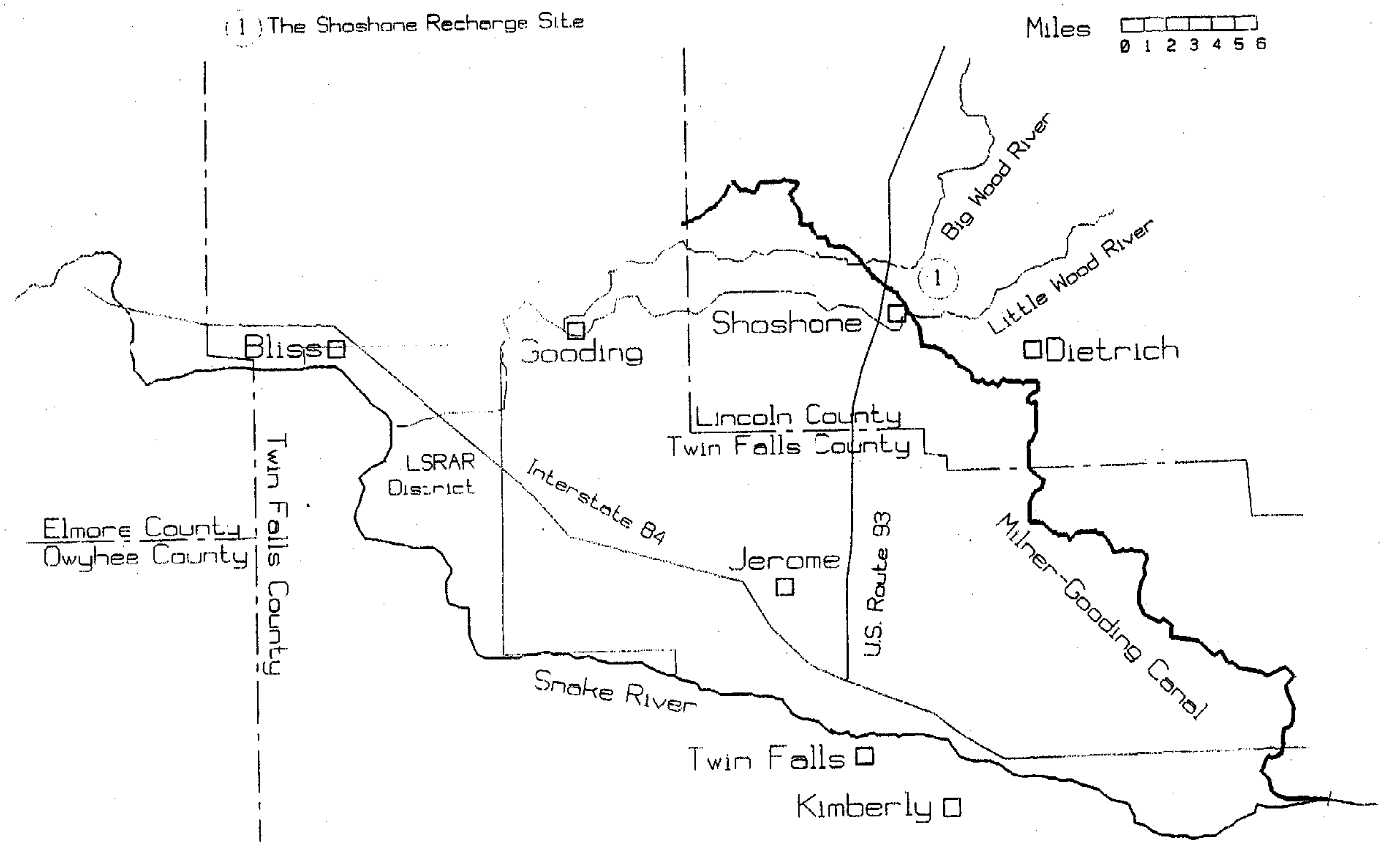

Figure I-1: The LSRAR District Boundary Map.

diversion structures, pay water wheeling costs, monitor groundwater levels and monitor groundwater quality in the recharge areas.

Current recharge sites used by the District are located outside the District boundaries. Two recharge sites have been used by the District to recharge the Snake River Plain aquifer. One site is located approximately three miles north of Shoshone, while the other is located near Carey. Each will be discussed in more detail in sections that follow.

I.D Maximum Capacity

Maximum capacity of the canals used by the LSRAR District is addressed in the appendices for North Side and Reservoir District #2. Maximum canal capacity becomes significant when canals are delivering irrigation water and are needed for delivery of artificial recharge.

II. Artificial Recharge Experience

The LSRAR District artificial recharge experience began in 1987 when the District was approved for operation by the state. Since that time the District, through American Falls Reservoir District #2, has accomplished the following recharge in a natural depression off the Milner-Gooding canal just north of Shoshone.

Year	Volume (AF)
1987	4,810
1988 - 1992	None (Dry years)
1993	13,806
1994	None
1995	51,303

In addition, the District estimates that approximately 75, 000 AF were recharged at a site near Carey in 1995. No charge or compensation transpired between the District and the state for this water. Furthermore, it is not clear whether the state considers recharge at this site to be normal seepage or valid artificial recharge. Until this uncertainty is clarified, our report will assume the site is not a candidate for the state's artificial recharge program, and the Carey site will not be discussed further.

III. Assessment of the Potential for Artificial Recharge

The Milner-Gooding Canal is used by the LSRAR District to deliver water to a natural depression in the lava flows about 3 miles north of Shoshone (T5S, R17E, Sec. 22) (Figure I-2). In 1995, the canal was used to deliver about 47, 000 AF of Snake River water and about 4200 AF of Little Wood River water to this recharge site. The site is currently capable of infiltrating about 450 cfs, probably for an indefinite period. The capacity of the site can be increased with minor structural modifications, perhaps to as much as the local carrying capacity of the Milner-Gooding canal -- 650 cfs. The site is relatively remote. It is, therefore, unlikely that recharge at rates up to 650 cfs will result in adverse impacts from elevated groundwater levels.

Site usage is limited by water availability, since the site holds relatively junior rights, and by winter operating restrictions. These topics are discussed in further detail in Appendix F, which describes American Falls Reservoir District #2.

IV. Description of Problems Implementing Artificial Recharge

Operation of the recharge site during winter months (December through the first half of March) is impractical. Possible ice damage to system components as well as inaccessibility of the canal system in the area largely prohibit operation of the system. Unlike other districts and canal companies diverting from the lower reaches of the Snake

River, the LSRAR District is not constrained by U. S. Bureau of Reclamation contract restrictions.

Ability to provide artificial recharge through the LSRAR District recharge site is proven. Averse impacts resulting from elevated groundwater levels or water quality degradation are unlikely, due to the site's remote location. Past experience, however, has shown that it is necessary to regularly monitor water levels and water quality in order to provide the necessary assurance to local residents that adverse effects are not occurring. Also, expanding the capacity of the site may require additional road and dike construction.

V. Conclusions

The Lower Snake River Aquifer Recharge District has several years of experience conducting artificial recharge of the Snake River Plain aquifer in the vicinity of the town of Shoshone. With improvements, the site used by the District for artificial recharge could increase recharge capacity from approximately 450 cfs to approximately 650 cfs. Some additional construction would be needed to obtain this rate of recharge. During winter months and peak irrigation season, water will not be available for use at the site. Adverse impacts from operation of the LSRAR District recharge site are expected to be minimal.

Details regarding further description of the LSRAR District recharge capability, combined with derivation of recharge capacity figures associated with the site, can be found in Appendix F.